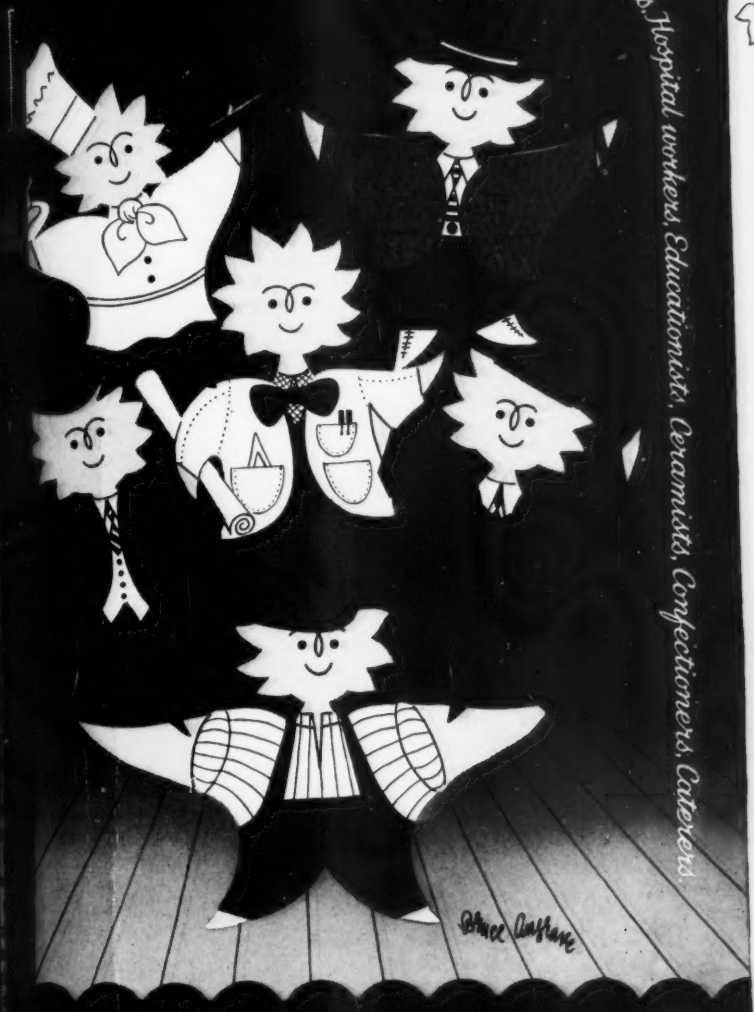
metal finishing

APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, ANODIZING, METAL SPRAYING and all METAL FINISHING PROCESSES

Vol. 4 No. 43 (New Series) JULY, 1958



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metal finishing Journal

July, 1958 Vol. 4, No. 43 (New Series)

AN INDUSTRIAL NEWSPAPERS PUBLICATION

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THIS JOURNAL IS DEVOTED TO THE SCIENCE AND TECHNOLOGY OF PAINT APPLICATION, ELECTRODEPOSITION, VITREOUS ENAMELLING, GALVANIZING, ANODIZING, METAL SPRAYING & ALL METAL FINISHING PROCESSES. THE EDITOR IS PREPARED TO CONSIDER FOR PUBLICATION ANY ARTICLE COMING WITHIN THE PURVIEW OF "METAL FINISHING JOURNAL" AND ALL SUCH ARTICLES ACCEPTED WILL BE PAID FOR AT THE USUAL RATES.

Contents

MOVING WITH THE TIMES

THE practice of using heat to fuse a glassy or vitreous material and to apply it to a metal surface for purposes of decoration is one which dates back for several millennia having been known to the Egyptians many hundreds of years before the birth of Christ. The glassy substance was known by the Arabic word "amel", preserved today in the French "email", and this word became adopted into the languages of the Western world. Hence to apply a coat of "amel" to an object was to "en-amel" it and by the usual processes of etymology, enamel came to mean both the material and the process.

Today the jewellery enamellers still use materials and methods which have changed but little with the passing centuries except that they now have at their disposal a much wider range of bright and interesting colours. The permanent and attractive surface provided by enamel, however, led to its adoption for a number of more utilitarian purposes and the end of the nineteenth century found enamel being applied to a host of domestic utensils and equipment. However, with the passing of the aspidistra and the antimacassar, much enamelled ware was also relegated to the limbo of out-moded things. On the other hand with the emergence of many new household articles such as washing machines, refrigerators, and electric irons, a new demand was created for a finish which was at the same time colourful and resistant to heat and other offensive influences to which it might be subjected in the course of its daily use. These requirements were admirably fulfilled by enamel and the manufacture of modern domestic equipment developed side by side with improvements in enamelling processes and in enamels themselves.

None of the improvements effected in the constitution of enamels, however, could overcome the fact, intrinsic in its nature and vital to its properties, that it is a glass, sharing many of the brittle characteristics of that material and requiring the input of a considerable amount of heat for its application to a metal surface. Advances in the technology of paint manufacture resulted in the emergence of paint finishes possessing certain of the desirable properties of enamel, e.g. high gloss, resistance to moderate amounts of heat and abrasion, and to certain offensive substances, but without the disadvantages of requiring high temperatures for their application or being liable to splinter or chip.

Once again therefore, some of the traditional applications of enamel have yielded place to other finishes and materials, but in the same way as took place in the first few decades of the century, the march of progress in other fields of human enterprise has maintained and extended the demand for just those properties which only enamel can provide. Gas turbines, nuclear reactors, even the vagaries of wind and weather, pose problems of corrosion and attack to maintenance engineers to which the answer in many cases is found in enamel.

Last month the Institute of Vitreous Enamellers staged their Annual Conference in Scotland, and a report of this meeting occupies the greater part of this issue. The attendance and the obvious interest in the activities of the Institute which have been given further impetus by the setting up last year of a Development Council for the industry, afforded clear evidence of the constant resurgence of the enamel industry and its readiness to exploit the unique properties of the coating which it fosters in every conceivable application.

Talking Points

by "PLATELAYER"

TOPICAL COMMENT FROM THE MAIN LINES AND SIDE LINES OF METAL FINISHING

STICKY PROBLEMS

THE fact that practically nothing will stick to polythene is one of its virtues, but many people must have wished that it could be satisfactorily bonded to metals. There would certainly be applications for bonded polythene in the metal finishing field, tank linings and plating racks being obvious ones. By using methods somewhat akin to those employed in bonding rubber to brass, Bell Telephone Laboratories in the U.S.A. now claim to have achieved success and polythene bonds on brass with tensile strengths of up to 1,000 lb. per sq. inch. can be produced. For attachment to steel, the latter must be brass plated first, which is of course a serious disadvantage where tank lining is concerned.

The bonding medium is a cement based on partially hydrogenated butadiene. A layer of the bonding agent 0.002 in. to 0.003 in. thick is applied, after which bonding is accomplished at temperatures of 150 to 232° C. and at pressures of up to 100 lb. per sq. in.

By a modification of the method it is also possible to bond hard rubber to polythene, but why anyone should want to do this it is difficult to imagine.

DISPOSING OF CUSTOMERS

A FRIEND of mine, who is not prone to exaggeration, recently telephoned the London office of one of our largest chemical firms and assures me that the following conversation about a product of which they are the sole British manufacturers actually took place :—

"I should like to verify some technical points about one of your chemicals as a matter of urgency."

"I am sorry, sir, but this is a Sales Office and there is no-one here who can deal with technical matters. If you care to write to us we shall refer your question to our experts and advise you in due course."

"I am afraid that we cannot wait that long, and as the query is quite a straightforward one, perhaps I could talk to someone in your head office about it ?"

"Oh, no ! I am afraid I cannot permit you to do that ! Our technical people have much more important work to do than to answer enquiries on the telephone from all and sundry."

Of course, my friend telephoned the Liverpool (or it may have been Manchester) office and got the information he wanted at once. The number is in the telephone book — in heavy type.

Customers, of course, are an awful nuisance, and they will interfere with the smooth running of an enterprise. They dislocate the timetables of buses by insisting on getting on and off all the time, interrupt shop-assistants engaged on important jobs, disorganize whatever goes on behind post-office counters, and so on. They really ought to be done away with.

FROM BAD TO WORSE

A RECENT American report describes a method of accelerating corrosion testing of electroplate by rubbing the specimens first with a paste consisting of a mixture of an abrasive and a surface active material. When this has been done the plate becomes completely wettable in a humid test atmosphere or in salt spray, and hence a much more rapid rate of attack takes place.

The fact that such a procedure can be carried out is itself an indictment of spray and humid atmosphere testing. Normally the cleaning procedure prior to testing is rather loosely specified, and it seems obvious from looking at specimens under test that the degree of wettability must be a potent factor in the type of result obtained. It is therefore evident that some standardization would be desirable, even if it should make the specimens look worse than they in fact are.

UNFAIR DEDUCTION

IN the review of mental health published by the Ministry of Health recently, one of the really striking items, to my mind, was the fact that while scientists and engineers had a very high rate of mental breakdown, foremen in the engineering industries had one of the lowest.

One cannot resist drawing the conclusion, which is probably quite unfair, that the stresses and frustrations induced in engineers by their efforts to get foremen to execute their designs or implement their plans, is equalled by the placid equanimity with which these self-same foremen happily jog along in their own sweet way. Or, for the benefit of the lower deck, it is the foremen who drive the engineers crazy, and not the other way round, in spite of what the average foreman often thinks.

THE INSTITUTE OF VITREOUS ENAMELLERS

THE 24th ANNUAL GENERAL MEETING AND CONFERENCE AT GLENEAGLES

Report of Proceedings and Works Visits

THE 24th Annual General Meeting and Annual Conference of the Institute of Vitreous Enamellers was held at Gleneagles Hotel, Scotland, on June 16—18, 1958. Over the period nearly two hundred members took part in the technical sessions, works visits and social activities. At the Annual General Meeting, which was held on the morning of June 16, Mr. J. H. Gray, A.I.Mech.E., chairman of Council, presided. The President, Mr. C. R. Wheeler, C.B.E., was unavoidably absent on the Continent and was represented by Mr. J. W. Gardom, A.M.I.Mech.E., past president of the Institute.

Following the formal approval of the minutes of the previous Annual General Meeting, Mr. Gray presented his report on the activities of the Institute in the nine months which had elapsed since the last Annual Meeting. Membership of the Institute continued to grow, although not at a very rapid rate, but it was gratifying to note the continued influx of junior members, particularly to the Scottish section, as it was on the young men in the industry that the future success of the Institute would largely depend. The Technical Committee, through its various sub-committees, has continued to investigate a number of problems relating to the application and use of enamel, and the Institute had been able to take an even more active interest in the work of some of the committees of the British Standards Institution.

The Summer School, which had proved such a popular feature of the Institute's programme in recent years, would again be held during 1958, the venue this time being Buxton, and the time late September.

A number of discussions had taken place, and were continuing, with a view to initiating a programme of sponsored research on some fundamental aspects of the enamelling process and it was hoped that the difficulties, which were mainly financial, would not prove insuperable.

Mr. Gray said that it gave him great pleasure to

Officers of the Institute at the Annual General Meeting. Left to right: Mr. W. T. Wren, incoming President, Mr. J. W. Gardom, past president, Mr. J. H. Gray, Chairman of Council and Mr. J. D. Gardom, Secretary.


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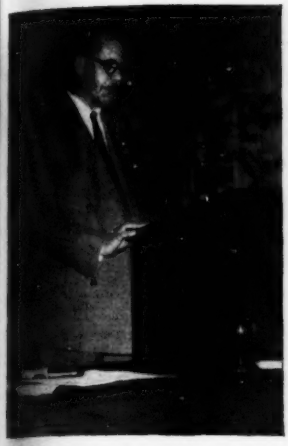


(left) Mr. C. S. Beers presents the first technical paper to the Conference. (right) A technical session in progress.

be able to report that on the initiative of the Institute an International enamelling organization had been set up of which he had been elected chairman for the current year, and of which Mr. J. D. Gardom, Secretary of the Institute, had been appointed secretary. It was hoped that the establishment of this body would foster technical collaboration between organizations with enamelling interests in Europe and Scandinavia to the common benefit of all concerned.

In concluding his report, the chairman expressed thanks to the chairmen and members of the various committeef, to the Secretary, Mr. J. D. Gardom, to the honorary treasurer, Mr. W. S. Grainger, and to the Section chairmen and officers for all their work in the interests of the Institute during the period under review. The Council also wished to put on record its very real appreciation of the most valuable help accorded to it and to the Institute by the retiring president, Mr. C. R. Wheeler, during his two years of office.

Following the presentation and adoption of the financial report, Mr. J. W. Gardom, deputising for the president, formally proposed the election of Mr. W. T. Wren, as president. The proposal was received with acclamation and Mr. Wren, having been invested with the Presidential Chain, thanked the Institute for the honour thus conferred upon him.

The formal business of the meeting concluded with the re-election of Mr. W. S. Grainger as hon. treasurer for a further term on the proposition of Mr. A. Biddulph, and the announcement of the results of the ballot for the election of members to fill the vacancies on Council. Those elected were Dr. B. K. Niklewski, Mr. S. E. A. Ryder, and Dr. W. H. F. Tickle.

Mr. W. T. Wren, the newly elected president, then proceeded to deliver his Presidential Address, after which the first technical session was held. The second and third technical sessions followed in the afternoon and in the evening a reception by the new President and Mrs. Wren was followed by dinner and dancing.

On the following day members proceeded by coach for a series of works visits in the Falkirk area, the works visited being The Carron Company, M. Cockburn and Co. Ltd., R. and A. Main Ltd. and Smith and Wellstood Ltd. After a most interesting tour of these works, members assembled for luncheon at the Ice Rink, Falkirk, where technical sessions were held in the afternoon.

The same evening the annual Conference Dinner was held in the Ballroom of Gleneagles Hotel. Members and their ladies were received by the President and the Chairmen of Council and their ladies, who were subsequently piped in, together

(*Continued in page 292*)

The Conference Dinner, 1958.

(a) *Piping in the guests to the Top Table. Mr. and Mrs. N. S. C. Millar followed by Mr. and Mrs. H. Rowse.*

(b) *Mr. L. Vielhaber (Secretary, Verein Deutscher Emailfachleute) followed by Mr. G. M. Menzies (chairman, British Steel Founders' Association), Mr. J. W. Gardom (I.V.E. past president), Mr. Gardom, Mr. A. E. Peace (president, Institute of British Foundrymen), and Mrs. Peace.*

(c) *Mr. W. T. Wren, president, I.V.E., followed by Mrs. Wren, Mr. H. V. Shelton, (chairman, British Bath Manufacturers' Association and British Ironfounders' Association), Mrs. Gray, Mr. J. H. Gray (chairman of Council I.V.E.), Mr. Leaver and Mrs. E. J. Leaver (manager, Carron Company).*

(d) *Mr. W. T. Wren, president and Mrs. Wren, with Mr. J. H. Gray, chairman of Council and Mrs. Gray receiving Mr. and Mrs. D. W. S. Hurst prior to the Conference Dinner.*

(e) *The toast of the Institute is proposed by Mr. H. V. Shelton.*

(f) *Mr. A. F. Peace replies for the guests.*

WORKS MANAGEMENT and HUMAN RELATIONS

by C. S. BEERS*

(*A paper presented to the Annual Conference of the Institute of Vitreous Enamellers, Gleneagles, Scotland, June 16—18, 1958*).

WORKS management should concern itself with the development of people as well as the direction of material things, therefore, from the outset, this paper will combine these two headings as one live subject.

There is, of course, a wide range of opinion regarding the definition of management especially in relation to the human factor but the most preferred definition both to give and to act upon can be summarized in the following few words. Works management is responsible for the employment of a first-class team of people to produce first-class products at the most economical price, to enable good wages and salaries to be earned by the team, and a good profit to be earned for the company.

In considering how best to set about organizing and administering these principles, one body of opinion will claim that almost any type of organization will work so long as the right people are operating it ; others will stress the use of charts, procedures and techniques and adapt the human factor to this structure. The middle path between these two views is probably the best plan, giving due consideration to the human factor and applying certain proved techniques, guides and procedures.

Morale training is most important as morale can make or break any organization. This training must come from works management in the form of honest and frank discussions and dealing with all matters that arise at whatever level. In other words, there must be no feelings of mistrust existing within the works organization. Everyone must be in a position to know that they can expect a fair deal without too much red tape.

A most important factor in works management is to know how best to delegate responsibility to other works executives. How often is it heard that persons will not accept responsibility in their jobs? Far too often, and in many cases this statement is made without foundation by persons who are either afraid to delegate responsibility to others, or have not learned the art of doing so.

A works manager's job is to make his unit tick smoothly. There must be no corrosion or undercurrent to retard this smooth running; therefore, it is imperative that all matters relating to both production and welfare, however small, must be dealt with before they become rusty and cause corrosion to slow down the works. To achieve this it is essential to have a first-class team to operate the policy laid down by management. Good human relationship is the foundation stone for loyalty of this team. In turn, each member of the team can only carry out his duties with confidence, providing he has the full responsibility of his section. In this way, the majority of every-day problems are speedily dealt with, so that only those matters calling for policy decision should be handled by the works manager.

So much for a basic formula for works management. Dealing with the various points in rather a more personal manner and in doing so, trying to introduce the works side of vitreous porcelain enamelling, it is kindly to express some personal views on building up a works team.

It is most essential for a works manager to have a sound knowledge of production throughout all stages from design to finished product. When dealing with the manufacture of appliances or ware for vitreous porcelain finish, a scientific knowledge of both engineering and art can be most useful. He must also like and understand men (women, alas, one will never understand !)

Providing the manager has these qualifications, he will be respected in relation to his position by all those under his command. This loyalty can only be earned by one's natural self. It is not acquired by adopting a pompous attitude or ruthless methods. Given a fair deal British people have always been found to be intelligent and decent, faithful, hard-working and prudent. Seven hundreds years of democratic striving means something really unique and worthwhile. Therefore, the British workman is not going to let anyone down, providing he receives the decent treatment he deserves.

The efficiency of works management and team enthusiasm depends upon having an agreed common objective. People can only help one another willingly and consistently if they have an agreed common objective of first importance for the emotional and intellectual satisfaction of them all. To satisfy both the emotional and intellectual senses, an atmosphere of security and full employment is essential. This is best created by teaching and practising quality production methods

* Works Director, Leisure Kitchen Equipment Ltd.

to ensure that the finished articles produced are something of which to be justly proud. It must not be forgotten, however that security and full employment can only be expected by those who work hard to earn it.

Enthusiastic team spirit is most essential in all works departments, but where better can this truly be displayed than in the vitreous porcelain enamelling department wherein is the opportunity and responsibility for applying this wonderful and beautiful finish to articles that fellow workers have produced.

In the vitreous enamelling department especially, men on the shop floor and in the office—tend to get together—this compels loyalty and builds up team spirit.

Providing good human relationship exists from top management down to shop floor chargehand, one can generally rely upon this natural grouping of people who have common interests and similar skills in their work. The result is a happy team whose main ambition is to earn good wages by producing first class finished ware.

Method of payment in the vitreous enamelling department is very important, and should have a very big bearing upon the quality of the finished work produced.

As an illustration the method adopted for payment in the author's vitreous enamel shop, where those employed work hard to earn good wages and salaries, will explain the principle more clearly.

Leisure is only sweet when it follows work well done !

Everyone in the enamel department, including mill room and pickling room personnel and all of those responsible for both operating and running this department, work as a team and all monies earned over and above the basic wages are equally shared by all in relation to number of hours they have worked, as it is considered that all of those engaged or employed in this department are absolutely necessary to maintain the production of highest possible quality ware. As such, they should enjoy equal shares for their efforts in the form of a bonus.

The basic wage is looked upon as being equal to a specific output of good ware passed by inspection and is measured in terms of number of square feet produced per man, per hour. All good ware produced and passed by final inspection over and above the basic amount is credited for bonus purposes and by this means, it will be appreciated that the controlling factor in relation to the bonus earned, is not only quantity, but also quality. By this principle, it is essential for each individual in the team to see that his part of the job is well done. Flexibility within the team is highly important as without this, the whole system could break down, and not only output but wages could suffer very heavily through absenteeism or through illness.

The main incentive of this scheme is first to produce good quality ware as no credit is given for any ware produced below final inspection standard. Final inspection, of course, is independent from enamel shop control. It is, however, the responsibility of the enamel shop team to ensure that all articles they are processing are up to first class standard throughout all stages of process, up to finished product. As a result, everyone in the team has an interest and is directly responsible for maintaining a high standard of production and payment.

The following is an example of the formula used for calculating the weekly bonus earning of the shop.

Assuming that every man employed in the department must produce 10 sq. ft. of good ware per hour to earn basic wage. If there are 50 men working 50 hours each, then to earn basic wage they must produce 50 x 50 x 10 25,000 sq. ft. of good ware. Suppose they produce 49,000 sq. ft. of good ware in 50 hours, then bonus is paid on 24,000 sq. ft.

Simply expressed as :—Sq. ft. produced per man hour $\frac{49{,}000}{50 \times 50} = 19.6$

Expressed as a percentage of basic earnings $= \frac{19.6 \times 100}{10}$

$\therefore$ Bonus = 96 per cent.

Taking responsibility for the work of a large number of people can be a great burden. Handling people can be unendingly difficult and complex. Co-ordinating production and maintaining output schedules and keeping oneself up-to-date with technical changes and modifications and doing so many of the responsible jobs of management can quickly wear a man out if he tries to act as a lone wolf. No man can be truly efficient if he adopts the attitude that no-one can do the job quite so well as himself. Under these conditions there is bound to be an atmosphere of unhappiness, lack of team spirit and general chaos and disloyalty.

Success in one's job brings a sense of honest duty honestly done. There is no joy quite equal to the satisfaction of doing one's best. It is therefore, terribly important for a works manager to spread this joy throughout his team so that each in turn can do his best without frustration, but helped by good leadership.

It is perhaps advisable to refer again here to the delegation of responsibility by works manager to his team, as it is a little difficult always to define where each responsibility starts and finishes, and there can either be some overlapping or narrow

margins which are not taken care of which call for explanation in a little more detail.

Shop managers, supervisors, etc., should be given full responsibility for running their own particular section ; they in turn, delegate certain responsibility to shop foremen and chargehands.

There are sections, however, in all works which are too small to have managerial or foreman control, and it is these smaller sections which can be totally disregarded by the various section leaders as being none of their business. Or the opposite could occur where each foreman in turn feels that he should have the responsibility of the smaller section. It is therefore necessary to bring in a communal understanding in relation to the control of the smaller bodies, otherwise situations can arise which, although rather petty, may lead to friction between departments.

These slight misunderstandings do occur and in consequence one should realise this and take the necessary precautions to see that they are dealt with in the very early stages.

For many years the author's Company have held regular daily production meetings. This system was introduced during the war when it was found that due to long working hours and having to deal with the many modifications that were being so frequently introduced at that time, responsible works personnel were subjected to a kind of nervous tension and occasionally there was an outburst of words and rather harsh statements made by one department against another. After a study of this situation, it was found that the main cause of these rather harsh words was that individuals were not fully aware of the causes of possible hold-ups in production due to modifications affecting another department's output. It was considered essential therefore, to find ways and means of bringing everyone into the picture so that they could completely understand the whole position in the future, and it was then that production meetings were introduced instead of trying to keep everyone informed by internal memo.

The main purpose of these meetings, which were attended by the production manager, works leaders for each production department, and representatives from maintenance, internal and external transport departments and stores, with the works manager in the chair, was of course, to discuss production problems and the cause of any hold-ups effecting delay to scheduled output. It was amazing how very quickly these troubles disappeared when these meetings were instituted and effectively run for a time. The reason for this was that the various department leaders were able to see very quickly, that it was far better to iron out their problems inter-departmentally with those responsible for the section, on the shop floor, rather than allow their problems to be openly discussed at the meetings.

These meetings create an atmosphere of friendship and understandings of one another's problems, and so create flexibility within the works by this common understanding, that many times production output schedules are maintained by the temporary transfer of man-power from one department to another, purely to achieve a common goal.

The point I would like to make however, is the continuity for these meetings, even when it would appear that the main problems for which they were devised have practically ironed themselves out, as it will be appreciated that there are always little problems occurring in a works which differ completely from any that have arisen at any time previously. There are also matters to be discussed and understood that may not appear to be production problems, but it must be realised that any kind of problem in a works must in some way or another affect production in the long run.

Having run these daily meetings for many years, it has now been found possible to relax slightly and hold them on 3 mornings of each week instead of 5.

There has been no attempt to limit the time which the meetings take, but it is generally understood that is should be reasonbly static, and that all matters can be cleared within ½ hour. There have been numerous occasions however, when the meetings have continued for much longer periods, but in all cases, it has been time very well spent.

Maybe there are different or better methods of dealing with problems than the one just outlined but, speaking from own personal experience it has been found to be an excellent way of dealing with these works problems and of creating a good understanding between all those charged with the responsibility of running the works departments. It also takes care of any slight overlap of responsibility that I have mentioned previously. Above all, it is an excellent means of maintaining good human relationship throughout the works.

Trade Unions

The selection of shop stewards is an important matter for consideration not only by the unions themselves, but also by works management. This position carries a certain amount of responsibility and loyalty both to the union and to works management. It is therefore, very desirable to make the finally appointed shop steward feel that he is welcomed by the management and not in any way resented.

A joint meeting between the union officials, works management and shop steward at the early stage of appointment is worthy of consideration, as it is far better for him to receive instructions regarding his duties from both parties at a joint meeting, than to expect him to know of these purely from his rule book.

Good shop stewards are a definite asset to works management, but it does not follow that regular meetings with them are essential or in any way necessary. If they are necessary, then there is an implication of something wrong with internal works organization, or some underlying cause upsetting good relationships with the workmen. It is works management's job to run the works and to see that all employees are productively happy in their jobs.

All matters calling for attention should be dealt with by works management and not by the Trade Unions. It is far better to take workpeople into one's confidence and explain fully to them any changes that are to be made in production methods, while at discussion stage, than to allow upheavals to take place by introducing changes without reasonable prior notice. It is not just good enough to convey these changes through the shop steward and expect him to convey all points fully to his union members—it is the duty of the shop floor management to deal with these matters in a personal and direct manner to his production unit and to see that there is no misunderstanding existing from the start. It is these small points that matter so much in maintaining good relationship, and if dealt with at the right time, will give the workmen full confidence in their foremen.

The ability of the foreman to deal quickly with the small things that so very frequently arise, both in relation to welfare and production, is equal in importance to his technical abilities. If small points are left without attention they so very quickly grow into major problems and can, without management's knowledge, get into the hands of the Trade Unions, and so very easily create atmosphere between Unions, works management and workpeople. Such circumstances are not only unpleasant, but in so many cases are totally unnecessary.

It isn't difficult to be both firm and pleasant when dealing with workmen ; it is the approach made by management teams to Workpeople when dealing with matters arising out of principle or production that is the first step in creating good or bad human relationship. It is a good point, for any person holding a position of responsibility occasionally to examine his own self in relation to his methods of approach to the people under his control.

There's an old story of the railway employee who was asked why he was tapping the wheels of each carriage, " I don't know ", he replied, " they just told me to tap them ! ". It seems silly, but cases like that can be found in many factories. Workers are told what to do, but not why.

The most important reason for explaining why to an employee is to enable him to think about his job in constructive terms. It lets him know that he is not just another cog in the wheel, but a member of an important section of the works, irrespective of his job. Above all, it minimises the need to give direct orders. In other works, it is a much nicer way of approach and achieves excellent results. For example :—

" Hey you, stop what you're doing and come over here " the foreman says, " Get a dozen of these finished off quick ! " He does the job, but he doesn't like it—he feels he's being pushed around.

If the foreman said, " Bill, we've got an urgent call for some of these, can you get me a dozen finished off by four o'clock ? " Bill likes this a lot better, he knows why—he's recognised as an intelligent workman when the foreman asks whether the job can be done by a certain time, and there's a little challenge to his ability in the question. He'll finish the units faster, and the foreman, by explaining why, has avoided the need to give a direct order.

Remember, few people like to take orders, but most will give of their best when asked to do something and given the reason why.

One can only be happy when one is with happy people—likewise, a man can only give of his best when he is happy and contented. Therefore, the works manager must pave the way for good productivity by ensuring that he has a happy works team. Summed up in three words—Good Human Relationship.

Discussion

MR. A. R. PARKES (Industrial Newspapers Ltd.) asked whether Mr. Beers included maintenance in his bonus system ?

MR. BEERS said that in the Enamelling Department the maintenance staff, as far as his company was concerned, did not enjoy or work within the bounds of the system operated in the Enamelling Shop. A means had been found, however, of bringing all his company's personnel into a bonus system. For maintenance staff and the like it was most difficult to find a system which would give them something, not just for the sake of giving it to them, but as a true incentive. The incentive worked upon for all these departments was finished ware leaving in the company's vehicles.

MR. JONES (Broom and Wade Ltd.) said that the question of human relationship was important. Referring to the Daily Production Meeting, were the workers represented at that meeting ? What proceedings were taken to put over any questions to the workers' representatives, for example questions of problems in the company, or programmes or anything appertaining to the running of the company ?

MR. BEERS said that at the Production Meetings a workers' representative was not invited. There was no so-called Works Committee. There were,

however, shop stewards in the various departments. He did not believe that there was a necessity for that sort of thing. His belief was that Works Management from top to the bottom through its stages of foremen, floor charge-hands and so forth, were the people responsible for running the works, and for giving ever/ piece of advice to the workers and those under them. It might be said therefore why have a shop steward at all ? A shop steward was necessary fundamentally because it was part of the agreement between the Union and the employers. If there were any fundamental changes in the company's production programme the shop stewards were brought in and the fundamental changes explained to them. However, it was Works Management's job to inform the workers and to keep them informed of changes. The shop steward could explain something of an arbitrary nature which did not probably affect production or otherwise, so that instead of having to address a mass only one person was involved and he could be brought into confidence. But the confidence of the workpeople generally must come from works management in all of its aspects.

MR. MACKINTOSH said that he had always found that when a group incentive scheme involved more than 15 it then got rather difficult. Did Mr. Beers find it quite easy to get the people to accept the equal share of a bonus based on square foot output, say, for shot-blasting, as against another one doing annealing or something else ? It seemed to him that the men doing the different or difficult jobs would have something to say about that method for the other jobs.

MR. BEERS said that the point made showed the apparent unfairness of any shop bonus to the various individuals employed in relation to their craftsmanship. But that was taken care of fundamentally in the first place by the craftsman being in receipt of a higher basic wage than the unskilled person, or should be. When it came to an all-in incentive bonus or a team bonus it was necessary to work on that in an enamelling department, because anyone employed in the department was so dependent on the quality of his workmanship coming out right with the quality of the job in the end. Of first importance, he thought, in any bonus scheme was that it was paying for quality and not quantity. No work that was below standard quality or at least below the quality of the dozens that arrived in the warehouse for dispatch to customers, should receive any bonus at all, be it the fault of the material or the fault of the department. That, he thought, was wrong. If anyone was operating that system he would advise them to alter it. That was the failure of so many of the bonus schemes. If bonuses were paid out because there was a fault cropping up, for example a little surface lamination or something wrong in the pickling and they said " This has nothing to do with us, we should receive a bonus," then this conception was wrong. They should not receive a bonus. A bonus should only be paid by the company on something that was going to earn the company money for the money they had spent on the raw material and on the work that had been put into it. The differential of payment should come from the differential of payment in relation to the ability from the person or his skill and not from the bonus. The bonus, should be an all-in embracing one and be paid out in equal shares in relation to the hours worked. The other part was taken care of by the " skilled " pay packet.

MR. MACKINTOSH said that as regards a man working in a shot-blasting chamber, it was harder to work in there for an hour than it was to stand in a workshop even for two hours.

MR. BEERS said he agreed entirely. But, if a shot-blaster was putting more effort into his job than a person who was watching the work going in and out of a furnace, that had no relation whatever to the quality of the work he was doing. As regards the person who was watching the work going into the furnace, the quality of his watching was just as important as the work that the man did in his shot-blasting chamber. Therefore, he felt that the shot-blaster should receive 50 per cent. of basic wage for the efforts he put into his job.

Suggestion Schemes

MR. POVEY asked whether Mr. Beers' company ran any form of scheme in which the works committee were invited to make suggestions ?

MR. BEERS said that his company did not have suggestion boxes around the works because it had been found that they were littered up with other than good suggestions. But it was a very healthy point, and it was one that should be pondered very greatly in a works. He thought that if one could operate the freedom of discussion through the reasonable and basic relationship between a foreman and the people in his department he felt that sort of freedom that was suggested was obtained in an improved way.

MR. J. W. GARDOM said that his view of bonus schemes was that if they were a sop to bad works management in that they were not correctly timed, then they were merely giving the personnel something for nothing. Mr. Beers, as he understood it, was giving the men so much money for work done. Was it essentially based upon the selling price of the finished article ? That might of course, be transferred into something else. He understood that the bonus scheme was done on a group basis ; in other words when a particular group turned out so much extra work, they earned

so much extra money and that money was then divided equally between the group. If that group was 10, were they still given all the money to be divided between 9 if one dropped out ? The other suggestion he wanted to make was that it was necessary to first create an overall bonus of 5 per cent. of the total earned, which could then give an incentive to one group to do their job properly, and not pass on to the other group something that they had left undone. Mr. Beers had said that some men did not like to pass on responsibility. In his opinion however, the majority of people were very willing to pass on responsibility or so they said. In this business of human relationship Mr. Beers had also said, it was necessary to have a man that technically understood the process. A technical man was not a suitable man in human relationship in the speaker's opinion ; he was dealing with something quite apart from the human race, and his whole training was one in which he could not quite understand what the other fellow was thinking about because he was probably thinking too much himself.

Bonus Scheme

MR. BEERS replying said that the bonus scheme which he had tried to portray reflected the price of the article to give a far greater quality job at a lower price. He was certain that a bonus scheme should operate only in relation to the quality of the job and not to the quantity. In the Enamel Shop particularly, his company did not employ the normal works inspectors. The normal work inspectorate only operated at final inspections. In other words, the Enamel Shop personnel themselves, under the guidance of the Foreman and of the Superintendent, were responsible for the inspection of the ware at all stages. That alone he thought created a wonderful atmosphere of responsibility in relation to the quantity output of quality products.

As regards the responsibility of foremen he considered it equally important that the foreman should be a good welfare man as that he should be a good technician.

Continuing Mr. Beers said that he did not agree with Personnel Managers. He could not see that a person holding a job as a Personnel Manager could truly know all the problems in every department as could the man on the shop floor, the charge-hand or the foreman.

Referring to the failure to pass on responsibility Mr. Beers said he had come across it on many occasions ; a person holding a job had not been efficient because he was not passing on responsibilities to others as he should have done. In general he had not handed over responsibility because he had been afraid to do so. In other words, he had been afraid that the person to whom he would pass on responsibility would take over his job.

MR. HOPKINS asked whether Mr. Beers would be prepared to say what proportion of the average earnings of his employees were bonus earnings.

MR. BEERS said that the main differential should come from the basic wages paid in relation to the ability of the man to do his job. In other words, the craftsmen were more highly remunerated than the semi-skilled and the unskilled and so forth. Therefore, the main differential should come from the basic rate according to the job. As far as the bonus was concerned a bonus was an incentive, and the incentive was to increase output or should be. But increased output, unless quality was taken very good care of, could be the undoing of so many bonus schemes. Therefore, it was most essential to watch that point very closely. But when it was a question of paying a man in relation to that bonus then, as he said earlier, the differential should come from that basic rate which was paid on the actual earnings in relation to a bonus to be paid out in equal shares in relation to hours worked, and not in relation to a percentage paid on his basic wage.

Regarding the bonus proportion of the average worker's wage he thought he should explain that the basic wage of a person did not include National Awards and so forth. In consequence it was not a very high sum of money irrespective of the craftsmen and so forth. His belief was rightly or wrongly, that any bonus scheme that paid less than 75 per cent. was quite useless. He would much rather see it in the 100, 125, or 150 per cent. bracket.

MR. HOPKINS said that he thought that Mr. Beers was giving the percentage on the basic wage which a bonus would represent. He was trying to discover what percentage was the bonus element in the total (gross) wage.

He was not referring to the whole works, but to the particular department to which the bonus applied. The incentive value to various workers in the scheme could not be financially the same as the incentive value of the bonus scheme ; because if they all shared equally financially the man who had a higher basic wage had a relatively smaller incentive inducement.

MR. BEERS said that in order to maintain output efficiency he believed it was absolutely necessary to train personnel to operate in a flexible manner, so that no longer was a man just a sprayer or a fuser or a chipper or a pickler. He was trained within the organization to operate any of those details as and when the position arose. Flexibility was absolutely essential in order to offset the problem of absenteeism. Continuing Mr. Beers said that the bonus was only applied to the basic wage, not to the basic wage plus Awards. There-

(*Continued in page* 268)

A Quarterly Survey of some of the Features in Finishing Literature from Abroad

by **SCRUTATOR**

WILL aluminium trim find any really significant applications on British cars this year ? If American trends are anything to go by, the answer could well be a pretty definite " Yes ". According to published figures [1], the aluminium usage in 1958 U.S. passenger cars now averages 52.4 lb. per car. Although automatic transmission assemblies constitute the largest single tonnage, trim applications in natural and colour finishes show the largest percentage increase — from 5.6 lb. per car in 1957 to 9 lb. in 1958. Leading the field for aluminium usage is the Cadillac Brougham with 305 lb. in functional and trim parts which include wheels and bumpers.

Nickel and Chromium Plating

In general however, applications for aluminium bumpers are very specialized and the days of the " chromed " steel bumper are far from over. In fact the demand for them, in this country at any-rate, should increase as our motor industry steps up its output. In America, Houdaille Industries Inc. are probably one of the largest manufacturers and a very interesting description has been published of the flat polishing, phosphating, forming and copper/nickel/chromium plating operations carried out at their Huntington Division.[2] If you're thinking of going into the bumper manufacturing business however, don't imagine you will get all the answers from this eight-page article featured on the front page as " How to Plate Bumpers " but titled more realistically inside — " Automobile Bumper Plating " !

The protection afforded by present day " chrome plating " on bumpers and other car parts as compared with pre-War " standards " is just about as controversial a topic as the pro's and cons of aluminium trim. So far the nickel plate — or perhaps alleged lack of it — has come in for most study and it is interesting to find that in America, Brown, Weinberg and Clauss[3] have now turned attention to the final chromium layer. They consider that the porosity of this is a key factor in the corrosion failure of nickel-chromium and copper-nickel-chromium deposits. Outdoor tests were carried out in Detroit and they found that the best improvement in the corrosion resistance of chromium plated fine-grained bright nickel deposits was obtained by using the bright chromium plating bath at 131°F. and at ratios of chromic acid (CrO_3) to sulphate of 150-200 to 1 and with chromium coating thicknesses of 0.05-0.08 mil. With buffed or unbuffed dull nickel, the thickness and character of the chromium plate was found to be not nearly as important as with bright very fine grained nickel.

Sulphamate nickel plating systems continue to find increasing use for engineering applications such as plating parts to improve fatigue life, to reduce fretting and wear and for electroforming to avoid distortion. Over seven and a quarter million gallons are in use in America and other countries.[4] Primary advantages of the system is the ability to be able to regulate stress in the deposit so that the nickel can be deposited in the stress-free condition or under compressive stress. The coatings are also stated to hold promise for high temperature coatings for missiles and rockets. Still in the sphere of electroplating for engineering uses, the Russians have reported very good results from the cold chromium plating of large punch-and-die sets.[5] The best composition of the electrolyte was found to be 250 gm. per l. chromic acid and 4 gm. per l. ammonium fluoride and plating was performed at 15-25°C. with a current density of 8-12 amp. per sq. dm.

Coatings

Hot-dip aluminized steel sheets will shortly be on the American market as it is reported that the U.S. Steel Corporation are getting ready to enter this field.[6] The 48-in. light-gauge continuous hot-dip galvanizing line at its Irvin Works is being modified to produce both zinc-coated and aluminized sheets (18 g or lighter). The change-over from one metal coating to the other can be made in 3 hours and the line is expected to be in production in late 1959. It will be interesting to see what applications this coated sheet finds.

Permyron[7] is a new colouring process for stainless steel which is claimed to make it possible to carry out severe forming operations after colouring without impairing the surface. In combination with the established method of rolled-in patterns, the colouring process could open up a host of applications for product designers. Published information is very scanty but the treatment is said

(Continued in page 292)

WEAR and TEAR of ENAMELLED SURFACES

By J. W. G. PEDDER*

(A paper presented to the Annual Conference of the Institute of Vitreous Enamellers, Gleneagles, June 16-18, 1958)

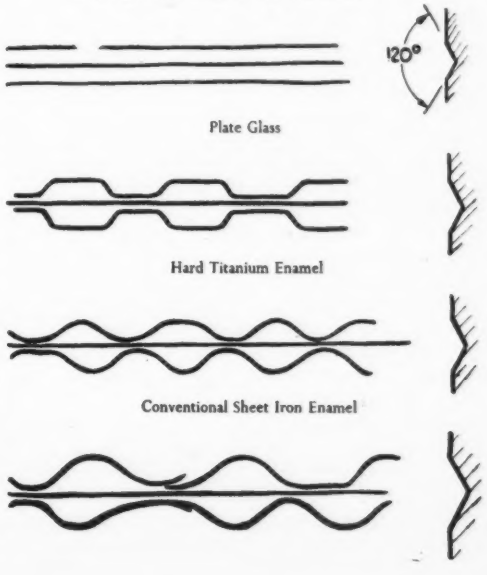
At the recent I.V.E. Conference J. A. Clark gave a review of various experiments in abrasion and scratch resistance of enamels. In view of the amount of work that has been carried out but not published, it has been thought desirable that the results of this work should be made available to assist workers who may be studying this important aspect of vitreous-enamel finishes. The bulk of this work was carried out six years ago. Whether a single scratch is being examined or hundreds of scratches superimposed on each other, the ultimate answer is the same—the resistance of the surface to wear. Standard dictionaries give the root of the word scratch as skratten (medieval English) or kraten (Swedish) both of which mean to scrape. The root of abrade is given as radere or rasum, also meaning to scrape.

It could be suggested therefore that the ultimate object is to assess the resistance of a vitreous-enamelled surface to scraping.

Some investigation has been made into the literature available in connection with similar studies on glass. These studies are not comprehensive but do bear a slight relationship to the subject under discussion. The Martens Scratch Hardness Tester (Holland & Turner, *Journal Soc. Glass Tech.* Vol. XIX, 1935) which is a conical diamond moved over the surface at different weights, resembles the apparatus described in Bailey's paper, "Scratch Resistance Power of Glass and its Measurement" (*J.A.C. Society*, Vol. XX, 1937). The remarks in this paper may well be thought to apply equally well to enamelled ware and the author points out that glassware in service is most unlikely to encounter sharp diamonds or other material greatly exceeding its own hardness, so the chief interest lies not in the type of scratch produced by a diamond but the pressure required to disrupt or destroy the surface with some softer and more blunt object. This applies particularly to vitreous-enamelled surfaces. The method used was to roll a $\frac{1}{8}$ in. diameter steel ball over the surface in such a manner that the pressure at which the first conchoidal break occurs is the measure of hardness. The balls used are precision steel ball-bearings, which could be obtained of uniform quality without difficulty. The application of the increasing load was by means of a lever arrangement. There was a wide variation in the hardness of different parts of the same plate.

Some early experiments on scratch hardness of vitreous-enamelled surfaces were made by G. Gelhoff and M. Thomas (*Zeitschr. f tech. Physik* 7 (1926), 105) who carried out numerous determinations of scratch resistance. A Koniger (*Sprechsaal* 71 (1938), 257) examined the influence of composition changes in enamels. Similar measurements were carried out by L. Vielhaber (*Emailwarenind.* 13 (1936), 219) (*Emailwarenind.* 15 (1938), 65), and he corrected American trials in the determination of scratch resistance in enamels and hardness of glazes, as per Auerbach. R. Weinig (*Emailwarenind.* 16 (1939), 160) examined the influence of the Vickers Hardness Test on various enamels, with the use of the diatestor. A similar examination was carried out in the U.S.A. by C. Hutchison (*Bull. Am. Ceram. Soc.* 18 (1939), 202). In

Fig. 1.—Diagrammatic representation of typical scratches in progressive degrees of hardness.



*Chairman, Vitreous Enamellers' Association

later years F. A. Peterson (*J. Am. Ceram. Soc.* 30 (1947), 94) described several methods and apparatus for examining scratch hardness and abrasion. In his "Examination of Enemalled Holloware" A. Ditzel (*Sprechsaal* 82 (1949), 19 & 28) carried out measuring of scratch hardness with a simple implement, and compared the values obtained with the wearing properties of different enamels. H. Kohl (*Sprechsaal* 83 (1950), 185) describes several testing methods for determining hardness and scratch resistance in his "Material Testing of Ceramic Surfaces, Colours, and Coverings," as well as the scratch process with sand, according to L. Kruger (*Ber. DKG*14. (1933), 13) and W. J. Scott (*J. Am. Ceram. Soc.* 7 (1924), 342).

Meyer has reviewed these experiments in his paper (*Eingegangen* 18 (VI), 1953). All of these experiments have usually led the authors to one conclusion: in no case has it been possible to calculate any factor or standard of abrasion or wear and tear resistance. They have served to indicate abrasion resistance by comparison, and are considered to be of theoretical interest only. Meyer concludes by suggesting that both a scratch method and measurement of weight loss should be used. Even so, one of these methods would generally be considered more important. Where gloss and appearance are of prime importance the scratch method would preponderate: if the enamel was being used as a protection to components being subjected to mechanical wear, then the loss in weight would be the first consideration.

In view of the fact that there was already in existence in the industry a diamond instrument for making scratch tests, it was thought that this would make a suitable starting off point for these investigations. The diamond block apparatus consisted of a brass block through which passed a double spindle carrying a small platform. The diamond was mounted in one spindle and the other prevented the diamond from rotating while in use. Weights were placed on the platform and the block was then drawn across the surface. Weights were added until a scratch was produced. It will be at once apparent that many questions can be raised as soon as a scratch is produced. How much weight was required and what relationship it has to the scratch, can it be repeated, how wide or how deep is the scratch, at what velocity and distance was the diamond drawn across the surface? What control is maintained over direction? Unfortunately on close examination the diamond had many defects. It was of unknown origin and not ground to any particular angle, size, shape or even in alignment with the cleavage of the stone.

To overcome these difficulties and variables the following apparatus was constructed (Figs. 2 and 3).

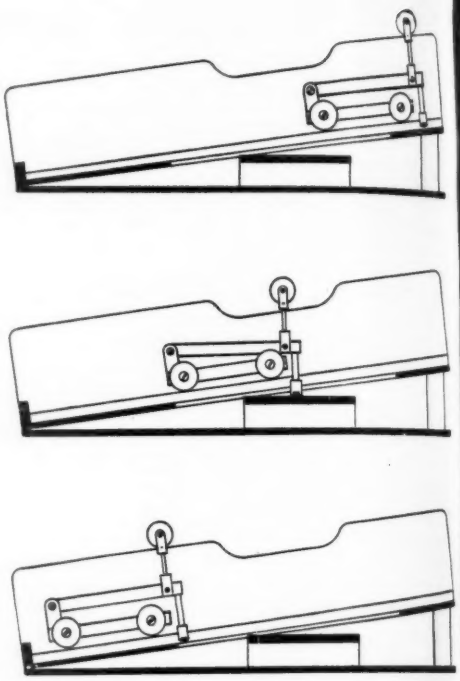


Fig. 2.—Diagram showing scratch-test apparatus in use.

A heavy steel carriage with phosphor-bronze wheels with a V groove cut round the rim was made as a base. An arm (with a cursor) to carry weights if desired, was held above the base in a short U standard and secured by conical screws which gave the maximum free movement. At the other end of the arm, which overhung the back of the carriage, a sleeve was fixed to take the diamond assembly. It was decided that gravity would be the most constant form of power to use after having considered some of the apparatus used to measure acceleration, etc. (Attwood's machine). To control direction the carriage was run on a track which could be inclined to any degree so as to increase or decrease the speed at which the diamond travelled over the surface. It was assumed that the speed of travel would be constant at a given angle. The diamond was made by and after consultation with a firm of diamond precision tool manufacturers, and consisted of a battle-axe edged South African diamond ground with a cutting edge of 120 deg. It was then possible to grind the cutting edge in line with the cleavage of the stone. It was also considered that a wider scratch for slight differences in penetration would be obtained with a minimum of wear and tear on the diamond. The penetration could easily be calculated from the well-known formula applicable to angle of 120 deg.

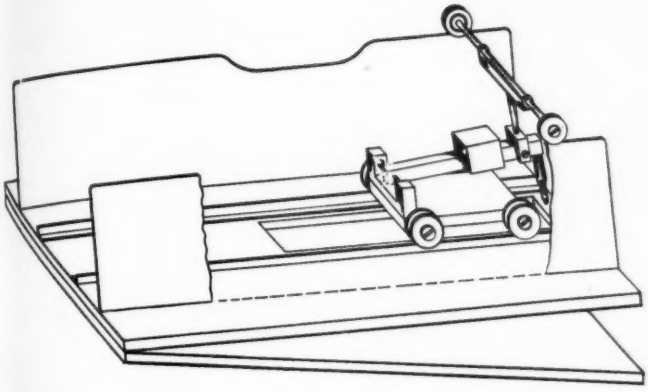


Fig. 3 (left). General view of scratch-test apparatus.

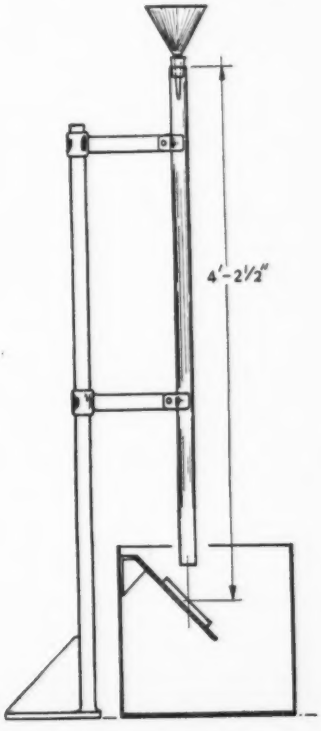
Fig. 4 (below). Steel-grit abrasion apparatus.

$$\text{depth} = \frac{\text{width of scratch}}{2\sqrt{3}}$$

In order that the commencement and termination of the scratch could be consistent, side rails to the carriage track were made, so shaped that with a suitable cam on the carriage, the diamond would always be lowered on to the sample at the same point, dragged across the sample for the same distance and then raised at the end of the run. (It was found that this procedure had no harmful effect on the edge of the diamond. After these experiments were made the diamond was submitted to the manufacturers, who said that the edge had not been impaired by chipping or otherwise). This shape of diamond had the desired effect of producing a more distinct outline to the scratch than the ragged and indistinct outlines made by the diamond used in the block apparatus. The general trend of scratches made formed a regular pattern and have been illustrated diagrammatically (Fig. 1). The softer the enamel the more irregular the cut, whereas plate glass gave a cut with parallel lined sides. With a battle-axed edged diamond three lines are produced, *viz :* a central one which is the lower point of the battle-axed edge, and two marks on either side corresponding with the side of the diamond. In addition, there is the disruption of the surface which is caused by the weight of the apparatus. This made the question of measuring the width of the cut extremely uncertain, but many observations were made and are tabulated. At this point it might be opportune to remember that the area of a cut 35.0 millimetres long by 0.0625 millimetres wide is only about 2.2 square millimetres. This measured by the side of say the bottom of a 6 in. or 150 mm. diameter saucepan of an area of 17.671 sq. mm. is only 12 to 100,000 by comparison.

As an alternative to an expensive diamond the possibility of using a gramophone needle which could be scrapped after every scratch was considered. A number of experimental " scratches " were made but owing to the sharpness of the point which could not be led into making a proper cut, this method was abandoned.

As all standards should bear some relation to the practical conditions under which the subject matter is to be used (*i.e.* laboratory tests and service tests should be identical) the question of continual scratching was considered. Where grinding wheels and liquid media are used, after a short while a quantity of the enamel would be abraded and would



then function in conjunction with the grinding media. This could alter the physical composition of the grinding materials. Similarly, if a liquid was added this could affect some enamels more than others. The object of the next series of experiments was to endeavour to measure the loss of weight by the abrasion of steel grit. Again using gravity as a means of propulsion a simple apparatus was constructed which consisted of a funnel fixed to the top of a vertical tube through which a known quantity of graded steel grit could be allowed to fall through a fixed distance on to sample plates which were held at a fixed angle (Fig. 4). Providing it was possible to weigh the samples a series of measurements of loss of weight could be recorded. The illustration shows the apparatus as constructed and used.

The grit used throughout all these experiments was Grade No. 10, blown free from dust. Ten lb. of steel grit of this size contains between 145,000 and 146,000 pieces of grit. This is based on weighing 10 samples and averaging the results.

A number of trial experiments were made to determine the amounts of grit to be used and the angle of incidence of cut. These results are tabulated from which it will be seen that 8 lbs. to 20 lbs. were used and the angle of incidence about 45 deg. Slight variations were immaterial and it was only when the sample plate approached a 90 deg. slope that the results were affected. This is due to the fact that the cutting was becoming ineffective and the plates were becoming subject to impact as well as cutting. This is of course an extreme, as in use the abrasion is generally caused by rubbing the surface in parallel lines and not at right angles to the enamelled surface.

Table I

Cast Iron Enamels	Total Loading	Average Width	Maximum Width	Minimum Width
(A) Soft black enamel direct on the iron	222 gm.	0.0375 mm.	0.0750 mm.	0.0250 mm.
	322 ,,	0.0265 ,,	N.D.	N.D.
	522 ,,	0.0875 ,,	0.1250 ,,	0.0625 ,,
	622 ,,	0.1000 ,,	0.1125 ,,	0.0875 ,,
	722 ,,	0.1300 ,,	0.1500 ,,	0.1125 ,,
(B) Soft white enamel direct on the iron	222 ,,	0.0375 ,,	0.0625 ,,	0.0125 ,,
	322 ,,	0.0625 ,,	0.0750 ,,	0.0125 ,,
	522 ,,	0.1000 ,,	0.1125 ,,	0.0750 ,,
	622 ,,	0.1030 ,,	0.1250 ,,	0.0750 ,,
	722 ,,	0.1250 ,,	0.1500 ,,	0.1000 ,,
(C) Acid-resisting white enamel (i) direct on sample (1)	222 ,,	0.0250 ,,	0.0250 ,,	0.0125 ,,
	322 ,,	0.0500 ,,	0.0625 ,,	0.0250 ,,
	522 ,,	0.0625 ,,	0.0750 ,,	0.0500 ,,
	622 ,,	0.0875 ,,	0.0895 ,,	0.0750 ,,
	722 ,,	0.1125 ,,	0.1250 ,,	0.1125 ,,
(C) Acid-resisting white enamel (ii) direct on sample (2)	222 ,,	0.0250 ,,	0.0250 ,,	0.0125 ,,
	322 ,,	0.0500 ,,	0.0625 ,,	0.0375 ,,
	522 ,,	0.0625 ,,	0.0750 ,,	0.0500 ,,
	622 ,,	0.0875 ,,	0.0875 ,,	0.0625 ,,
	722 ,,	0.1125 ,,	0.1250 ,,	0.1125 ,,
(C) Acid-resisting white enamel (iii) over matt ground coat	222 ,,	0.0250 ,,	0.0250 ,,	0.0125 ,,
	322 ,,	0.0500 ,,	0.0750 ,,	0.0250 ,,
	522 ,,	0.0625 ,,	0.0750 ,,	0.0625 ,,
	622 ,,	0.0875 ,,	0.1000 ,,	0.0750 ,,
	722 ,,	0.1125 ,,	0.1125 ,,	0.1000 ,,
(D) Hard but not acid-resisting (i) enamel direct on sample (1)	222 ,,	0.0125 ,,	0.0250 ,,	0.0125 ,,
	322 ,,	0.0250 ,,	0.0500 ,,	0.0125 ,,
	522 ,,	0.0625 ,,	0.0750 ,,	0.0500 ,,
	622 ,,	0.0875 ,,	0.1125 ,,	0.0750 ,,
	722 ,,	0.1000 ,,	0.1125 ,,	0.0875 ,,
Sheet Iron Enamels				
(M) Self-opacifying titanium cover-coat (i)	522 ,,	0.0125 ,,	0.0125 ,,	<0.0125 ,,
	722 ,,	0.0125 ,,	0.0125 ,,	<0.0125 ,,
(M) Self-opacifying titanium cover-coat (ii)	522 ,,	0.0125 ,,	0.0125 ,,	<0.0125 ,,
	722 ,,	0.0125 ,,	0.0125 ,,	<0.0125 ,,
(N) Antimony opacified cover coat (A.R.) (i)	522 ,,	0.0625 ,,	0.0875 ,,	0.625 ,,
	722 ,,	0.1125 ,,	0.1250 ,,	0.0875 ,,
(N) Antimony opacified cover coat (A.R.) (ii)	522 ,,	0.0625 ,,	0.0750 ,,	0.0500 ,,
	722 ,,	0.1125 ,,	0.1373 ,,	0.1000 ,,
(O) White zirconium cover coat	522 ,,	0.0750 ,,	0.0875 ,,	0.0625 ,,
Miscellaneous				
Glass microscope slide	522 ,,	<0.0125 ,,	—	—
	722 ,,	0.0125 ,,	—	—
Belgian plate glass	522 ,,	0.0250 ,,	—	—
	722 ,,	0.0375 ,,	—	—

Table II

Sample	Load	WIDTH		
		Average	Maximum	Minimum
Self-opacifying titanium cover coat	(1) 522 gm. (2) 522 ,, (3) 522 ,,	UNMARKED		
Antimony opacified cover coat (A.R.)	(1) 522 ,, (2) 522 ,, (3) 522 ,,	UNMARKED 0.0625 mm.	0.0750 mm.	0.0125 mm.
White zirconium cover coat	(1) 522 ,, (2) 522 ,, (3) 522 ,,	0.1125 ,, 0.0375 ,, 0.0625 ,,	0.1375 ,, 0.0500 ,, 0.0875 ,,	0.0250 ,, 0.0250 ,, 0.0500 ,,
White zirconium cover coat	(1) 322 ,,	0.0625 ,,	0.0750 ,,	0.0500 ,,

RESULTS

Brass Block

The first trials by the diamond and brass block method were mainly on cast iron enamels where the range between the softest and the hardest in commercial use would give a wider range of results. The scratches were made with various weights. The scratch made was subsequently measured by a microscope with a micrometer eye-piece previously calibrated against a micrometer stage. A minimum of 20 readings was taken over a length of 35 millimetres. The object of carrying out this number of tests was to determine the most reasonable load that could be obtained and used, within practical limits. It would appear that the total load of 522 grams could be standardized at 500 by having a hollow spindle and using mercury to make the adjustment for the weight. If the limitations of this method of test block are borne in mind, it seems that some differentiation can be made in surface hardness which could be repeated, but it is questionable whether extreme refinements are really necessary.

The velocity with which the block was moved in connection with these experiments was approximately 3 cm. per second. These results are summarised in Table I.

It was observed:—

1. Scratches on cast iron were interrupted and had ragged edges.
2. Scratches on sheet iron were almost continuous but had ragged edges.
3. Scratches on glass samples were of the resemblance of a cut and had parallel sides.
4. Scratches on enamels were of the nature of a crushing or tearing of the edges.
5. There was a tendency for the scratches on enamels to widen on standing through flaking off from the ruptured top skin of the enamel. This also tended to make the scratches more irregular.

From the above results it was considered doubtful whether slight differences of hardness could be determined, especially in the case of softer enamels where the scratch was of such a ragged nature.

For the following series of experiments the diamond was substituted by a "loud tone" gramophone needle which was replaced after each scratch had been made. The results shown in Table II were obtained.

Observations

(1) The scratches made are of the nature of a ploughing of the surface and not of a cut or crushing, and are very inconsistent in width.

(2) No two needles seem to give the same result.

(3) A lighter load than that standardised in previous work (522 gm.) gave a slightly cleaner "scratch" on the softer enamels, but the same loading would not produce a scratch on a harder enamel.

(4) The width of the scratch made by the lighter load varied little from that made by the standard 522 gm.

(5) A metal point such as a gramophone needle gives inconsistent results when used in the Brass Test Block to determine enamel hardness by the Scratch Test.

Travelling Diamond

Following the previous two series of experiments the three samples used in the last experiment were subjected to test with the apparatus shewn in Fig. 2. The conditions were as follows:—

Samples. Three sheet iron enamels on 4-in. squares were used. These were selected from those referred to in previous reports and to which the same symbols have been applied. Cast iron enamels were not tried, as it was assumed that results would be similar.

Load on diamond: 830 gm.

Angle of Inclination: 11 deg. from horizontal.

Determinations: Three plates in each enamel.
Two scratches on each plate.
Total—six scratches.
Length of scratch examined =approx. 5 cm.
No. of measurements taken =10 over the 5 cm.

Results

(M) Titanium Enamel Acid-resisting.

	Minimum Width mm.	Maximum Width mm.	Average Width of Crushed Area mm.
A.	0.075	0.1875	0.125
			0.125
A.1	0.05	0.2125	0.1375
			0.1556
A.2	0.0125	0.1875	0.1438
			0.1413

(N) Acid resisting but not titanium based enamel.

B.	0.0375	0.2125	0.1484
			0.1844
B.1	0.025	0.275	0.1909
			0.1795
B.2	0.025	0.225	0.2063
			0.1875

(O) An ordinary antimony opacified white Cover Coat.

C.	0.0375	0.275	0.2425
			0.24
C.1	0.0125	0.3	0.2531
			0.1938
C.2	0.0125	0.25	0.1768
			0.2265

Comments and Summary

The blade-shaped diamond made a mark of definite outline, the width of which could be measured. This was a great improvement over the ragged edge scratch made by the pyramidical diamond. The load required was more than the greatest applied to the pyramidical diamond of 722 gm. This blade-shaped diamond with one edge leading caused a much lighter scratch, and in some cases none at all. The surface of each enamel broke in a characteristic fashion, *i.e.* a continuous deep cut flanked on either side of a rectangular area, thought to be cracked or crushed enamel. In order to make the necessary measurements, the balloons were measured at their widest points, and the average recorded. It is known that the above enamel marked (M) cannot be scratched by hand with a sharp steel blade, (N) hardly at all, and (O) readily. The results of the scratch are in accordance with this, and this can be seen more clearly if the average width of the balloons are calculated in units. One unit equals 0.125 gm.

Enamel	M	1.104
	N	1.493
	O	1.327

While this method of evaluation of the resistance of enamel to scratch would include differences of a sufficiently small order to be useful in development work, it could not be used as a basis for standardization. The careful descriptions required in interpreting the results and the extreme improbability of getting uniformity of technique would not enable anybody other than a skilled technician to use the apparatus.

ABRADER

In order to determine the angle of incidence of impact a number of trials were made as shown in Table III. The total enamel thickness, it will be seen, was of the order of 0.010 to 0.011 in. Ten lb. of grit was poured into the funnel in each case and the time of fall was also observed. This remained within reasonable consistency varying only a matter of about 3 seconds between the fastest and slowest times, and for all purposes could be considered uniform. It will be observed that as the angle of incidence increased, so the loss in weight also increased. The angle of incidence chosen from these figures was 45 deg. The effect of variation of thickness was then tried and the results of varying thickness of enamel are summarized in Table IV. The increased resistance to abrasion of thinner coats is probably due to the fact that the thinner coat was more homogeneous than the thicker one, there being a minimum of bubble structure in the thinner film of cover coat.

Table V shows the influence of under-firing. The fact that underfired enamels appear to give good results from the abrasion test is due to the fact that there are a number of points (by which is meant particles of frit that have not been fired down) and sharp edges from which the grit ricochets, but as is known, the adherence of underfired frit is very small. This is borne out, in fact, by the result of tests made in a highly refractory enamel which had a rough surface when fired at over 1,000°C. (The last item in Table VI which could not be scratched under conditions tried in earlier experiments).

Table III. *Variation of incidence of shot on standard titania-based enamel for sheet iron.*

Sample No.	Enamel Thickness in 0.001 in.		Angle (deg.)	Discharge Time in seconds	Loss in weight in 0.0001 gm.
	Grip	Total			
17	5	11	45	77.5	52
18	5	11	45	78.0	49
19	4-5	10	45	74.8	53
20	5	10-11	67	76.0	105
21	5	11	67	75.4	123
22	5	11	67	75.6	113
23	4-5	11	38	75.0	39
24	4-5	10	38	77.8	43
25	5	11	38	75.6	76
26	5	11	45	76.0	57
27	5	11	45	74.8	76

10-lb. grit used in all experiments.

Table VI gives a summary of typical results by the travelling diamond method and the use of 10 lb. and 20 lb. of grit by the abrader. The results are in line with other investigators' findings

Table IV. *Variation of thickness of cover coat of titania-based sheet iron enamel.*

Sample	Cover coat thickness in 0.001 in.	Loss in 0.0001 gm.
11	10	35
12	10	38
13	10	35
14	10	35
15	9-10	33
16	8-10	43
17	6	52
18	6	49
19	5	53
26	6	57
27	6	76
60	7	46
62	7	57

Average samples 11-16 .. 0.0037 gm.
Average samples 17-62 .. 0.0056 gm.
10-lb. grit used in all experiments.

inasmuch as titania-based enamels are more abrasion resistant than other enamels. It would also seem that once the surface skin has been destroyed there comes a point when the loss in weight might be directly proportional to the amount of grit allowed to fall on the surface. In the case of sample (M) the point has not been reached with 20 lb. of grit ; with samples (N) and (O) the point is before 10 lb. have been used, and with plate glass somewhere between 10 lb. and 20 lb. of shot.

A number of trials have been made with a view to ascertaining the minimum amount of grit required to disrupt the surface. This is not very easy to determine because it is necessary to watch the sample and stop the flow of shot immediately the break occurs. To do this through a stream of grit requires many qualities in the observer. These experiments did bring out a very interesting point between stove-and vitreous-enamelled samples. It appeared under the microscope that the abrasion of the stove-enamelled surfaces caused the film to disintegrate in flakes, very similar in form to crazing in vitreous enamels, and become detached, whereas on the vitreous-enamelled surfaces the relatively thinner tops of the bubbles were broken and the remaining structure then bore the force of abrasion with much more resistance.

Fig. 5 shows at a magnification of X 50 a continuously abraded surface from which the whole

Fig. 5.—*An abraded enamel surface from which the whole of the top skin has been removed revealing the bubble structure. Visible within the ring are the bases of the grooves caused by drawing utensils across the enamelled surface* (*X* 50).

Table V. *Influence of underfiring of titania-based sheet iron enamels.*

Sample	Fusing temp. °C.	Loss in weight in 0.0001 gm.
66	790	46
67	790	37
68	790	43
17	815	52
18	815	49
19	815	53
26	815	57
27	815	76
61	815	46
62	815	57

Average samples 66-68 .. 0.0042 gm.
Average samples 17-62 .. 0.0056 gm.
10-lb. grit used in all experiments.

Fig. 6.—*(left) A single scratch made by the travelling diamond on a soft enamel surface* (*X* 50).

Fig. 7.—*(right) A single scratch made by the travelling diamond on a hard enamel surface* (*X* 50).

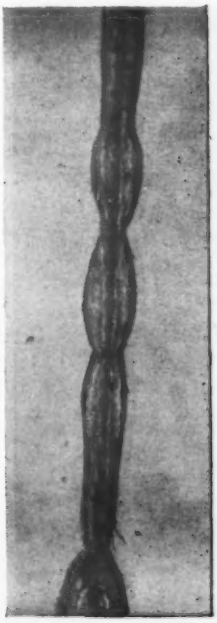


Fig.8.—The intersection of two scratches made by the travelling diamond in an enamel surface.

of the top surface has been removed revealing the bubble structure. The parallel lines discernible (ringed) are the bases of the grooves caused by drawing utensils across the enamelled surface.

Fig. 6 shows a photograph of a single cut made by the travelling diamond on a soft enamel. The width of the scratch at the top surface is shown by the two white lines running the length of the scratch.

A similar scratch is shown in Fig. 7 but in this case it is made in a hard enamel. Here it will be seen that the overall width of the " balloons " and the width of the scratch between the white lines are much less than in Fig. 6.

During abrasion scratches are superimposed on each other and Fig. 8 shows the intersection of two scratches. When a sharp point meets a scratch it does not go straight through the groove but jumps or overrides the scratch and drops slightly beyond. This can be assumed since the " balloons " of the second scratch are not continuous. The white areas visible inside the " balloons " are conchoidal fractures below the vee formed by the cutting instrument. These may be formed by pressure but it is also suggested that they may in part be due to the release of internal stresses when the surface tension is altered by the rupture of the enamel surface.

Table VI. *Summary of typical results.*

Subject	Scratch Method	Abrader (10 lb. shot)	Abrader (20 lb. shot)
Titania-based, A.R. Enamel (M)	0.1380	56	132
Acid-resisting but not titania-based enamel (N)	0.1828	342	560
Antimony opacified white cover coat (O)	0.2221	582	661
Plate Glass	0.125	129	362
High Refactory Enamel	—	70	196

Scratch method = average width of scratch in mms.
Abrader method = average loss in weight in 0.0001 gm.

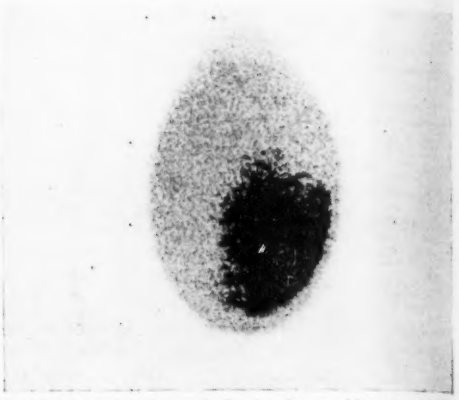


Fig. 9.—A painted sample having been subjected to 10 lb. of grit in the abrader.

The upper row of photographs in Fig. 10 show a standard ground coat subjected consecutively to 10, 15 and 20 lb. of shot by the abrader. The lower row shows a titanium self-opacifying frit subjected to the same treatment. In the case of the grip coat, the enamel is stripped in part showing the base metal. The dark area in the titanium coated sample shows grip coat only and not base metal.

For comparisons a painted sample is shown in Fig. 9 having been subjected to a 10 lb. of grit by the abrader. The dark area shows considerable erosion of the base metal.

It is quite clear that there are two stages in the destruction of a vitreous-enamelled surface. First, there is a resistance of the top skin which after destruction is followed by the resistance to abrasion of the sub-layer. As a comparison to loss in weight the abraded surfaces have been examined for variations in reflectance. These results are not convincing. It appears that the abraded enamel picks up small quantities of iron which adhere to the surface and which improve the reflectance, but, of course, are extremely erratic. A number of comparisons have been made with competitive finishes. Some forms of plastic and stove enamelling were unaffected by the diamond method. This is due to the fact that

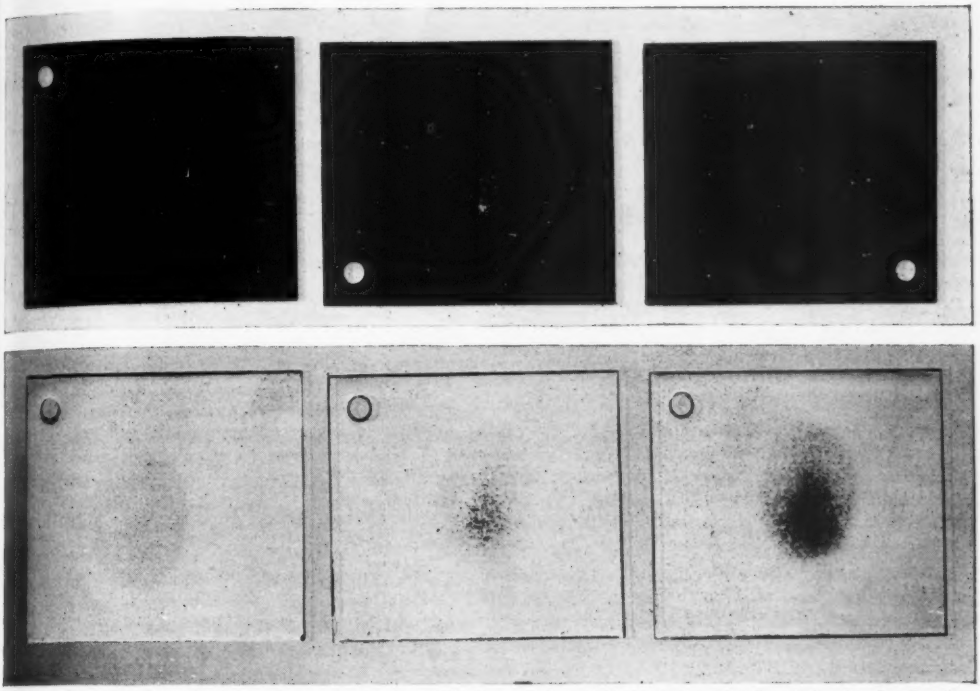


Fig. 10.—(top row) A standard enamel ground coat after subjection to (left to right) 10, 15 and 20 lb. of shot by the abrader. (Bottom row) A titanium self-opacifying enamel after subjection to (left to right) 10, 15 and 20 lb. of shot by the abrader.

the diamond slides over the highly polished surface of the material.

The question of abrasion of enamels opens up a very wide field of research into the surface conditions of vitreous enamels. Once the top skin of the enamel is broken a number of new conditions arise. First, the surface tension of the enamel is altered : enamelled components do not get the long annealing treatment to which glassware is subjected to relieve as many strains and stresses as possible. It is evident very much in the case of soft enamels. If a runner from a frit kiln when it is being tapped is tested it will be found that it is practically acid proof. The same enamel when ground and fired is the reverse. The latent energy in glass that has been rapidly cooled is well known ; this used to be demonstrated with Prince Rupert Drops. The surface tension of enamels calls for serious investigation. The standardization of any apparatus to give results that will determine whether an enamel is acceptable from an abrasion resistance point of view or not, will require a great deal of attention. One big problem will be the base or material with which to compare enamels. From the results it does not appear that plate glass which is homogeneous and of reasonably constant composition is really suitable although something of that nature is desirable.

The author acknowledges the assistance he has received from members of the Development Laboratory of Escol Products Ltd., under the guidance of Mr. E. Lawrence, in making the multitude of observations which were necessary in the compilation of this paper.

* * *

MR. J. W. G. PEDDER, presenting his paper, said that the attributes of vitreous enamels fell into two classes, namely, physical and chemical. During the last few years much more attention had been paid to chemical construction and behaviour of enamel than to its physical properties. The latter had been taken too much for granted. The fundamental characteristic of an enamel was its adhesion. A diamond-hard enamel that was acid and alkali-proof, which did not adhere to the bare metal or grip coat, would be useless.

It was difficult to make suggestions as to what was the next most important characteristic of an enamel. These were well defined until the question of abrasion or wear and tear was reached. Whether enamel had abrasion resistance or chemical resistance must be considered in relation to the purpose for which the finished article would be used.

(*Continued in page* 268)

Wear and Tear of Enamelled Surfaces

(*Continued from page* 267)

Discussion

MR. HURST asked Mr. Pedder whether in the abrasion tests the grit used was steel or cast iron ?

MR. PEDDER said that it was the ordinary, commercial chilled-iron grit.

MR. BOUGHTON referring to the abrasion tests asked whether the under-structure was taken into consideration ? It was mentioned that the micro-scope-glass was very hard, but plate glass was not so hard and this involved a softer enamel in which the abrasion resistance decreased. The softer materials, he thought, had a larger under-structure.

MR. PEDDER, replying, said that plate glass and micro-glass had unevenness. There was no question of bubble structure there and a clear, well-defined coat was obtained, but with vitreous enamel surfaces there were two stages. The top skin presented one problem, then there was the bubble structure underneath which presented another one altogether. Once the top structure had gone the bubble structure underneath did more or less present a surface which was abraded in proportion to the amount of grit that was allowed to fall on it.

MR. MILLER asked if any tests had been done of abrading dry process enamels. On a dry process enamel he had found that quite glossy surfaces were obtained but with a wet process it was not possible. As regards the configuration in the paint film which was abraded by the grit or shot, what sort of bond was there between the paint and the metal ; was the metal treated in any way ?

MR. PEDDER said he had not tried any experiments on dry-process enamels ; he would expect the method of the application of dry-process enamels to give homogeneity. The first layers put on were fused, in fact a series of layers that fuse were built up. But with wet-process enamel when the sprayed coating was put into the furnace the heat application was from the top so that the top fused and sealed over. That was one reason why a bubble structure was obtained with wet-process enamels. The top layer fused over and did not allow the water of combination to be released. But there was no water in the case of dry enamel. He would expect a dry process enamel to behave in a very similar manner to a piece of glass.

As far as the paint was concerned, which was used on the painted sample, this was the usual type of commercially available stoving enamel applied to the degreased sheet and stoved at about 250°F.

DR. STAGMEIER (Germany) asked whether any comparative measurements had been made between the Taber Abrader and the author's apparatus. Also had the same enamel been measured at various spots, *e.g.*, those parts where the enamel had cooled earlier and in other parts where it had cooled slowly ; in other words had the influence of the annealing been considered. Did Mr. Pedder measure the widths of the bubbles ? He could imagine on those parts where the enamel had cooled very quickly the bubbles would be very wide, and in other parts where it had cooled slowly they would not be so wide.

MR. PEDDER said that most of the experiments were carried out a long time ago, and as yet he had no Taber Abrader available therefore no comparisons had been made. With regard to the bubbles he thought that with a harder enamel which had more resistance generally it would be expected that the bubbles would be smaller.

Works Management and Human Relations—Discussion

(*Continued from page* 257)

fore, the builder of a man's wage packet was first and foremost the number of hours he had worked at basic rates. To those number of hours then there was the addition of the National Awards if any. Overtime was not taken into consideration at all for calculation of bonus.

MR. W. T. WREN (President) said that if a man took home gross pay, say of £20 what percentage would be the bonus ?

MR. BEERS said that he could not answer this because the structure of the man's wage packet was such that first and foremost he received a basic wage. The incentive bonus was paid directly in relation to that.

MR. WREN said that it must have some relationship to the gross wage.

MR. BEERS said that supposing a man was receiving 100 per cent. bonus, he would think that it would be roughly 60 per cent. of his gross pay.

MR. PETTER asked whether Mr. Beers found any dissatisfaction among his work-people if the bonus fell very much ? What was the attitude to the way workers looked on the bonus ; did they treat it as part of their pay, or did they prefer to get it altogether ?

MR. BEERS replying said that if something was wrong in the works whereby the worker could not enjoy the bonus it was not his job to put it right, but that of the management. It was too late to have a production meeting *after* the damage was done. A workman was employed to do his job properly, to handle his basic materials so that he could do his job correctly and pass it on to the next employee to do his job.

A REVIEW OF ZIRCONIUM BATH ENAMELS

By W. A. ROSS

(*A paper presented to the Annual Conference of the Institute of Vitreous Enamellers, Gleneagles, June 16 to 18, 1958*).

Introduction

THE main developments in zirconium bath enamels have taken place in the past decade, and it is in post-war years that practical zirconium wet process enamels have been put into general use, although the use of zirconium oxide in enamels was investigated as far back as 1911[1]. This paper is meant as a review of modern developments in order to help the enameller to understand a little more about this type of product.

In 1934[2], the use of zirconium oxide as an opacifier was recognized and investigated by Kinzie and Commons and later in 1940[3] by Andrews and Yates who determined the effect of some other constituents on the solubility of zirconium oxide in enamels. Later work in 1941[4][5] by King and Andrews differentiated between type I and type II specification and explained some of the conditions controlling the recrystallization of zirconium oxide from melts, and this study was the basis for the development of the modern zirconium opacified enamels.

This review is concerned with those enamels which are opacified by zirconium compounds crystallizing out of the melt during firing. These are the type II enamels described by King and Andrews[4].

Theory of Recrystallization

It is a well known fact that many salts are more soluble in hot water than in cold. Similarly, in glasses or enamels, which are liquid when hot, many compounds are more soluble in very hot mobile glasses then in colder, more viscous glasses. The mechanism of this behaviour is analagous to that of salts and water but not necessarily the same. There are some fundamental differences.

Explained simply, a glass when heated to 1250°C may dissolve 10 per cent zirconium oxide but when the same glass is heated to 800°C it may only be capable of dissolving 5 per cent zirconium oxide. Thus the zirconium tends to crystallize out and give opacity.

The degree of opacity or reflectance of an enamel is dependent upon several factors as under :

1. The number of insoluble crystallites in the enamel.
2. The size of the crystallites.
3. The difference in refractive index between the crystallites and the glassy matrix.

All these factors must be accurately controlled in zirconium enamels if consistent results are to be obtained. The greater the number of crystallites present, then the larger the number of reflecting surfaces which are available for scattering the light and consequently the greater the reflectance or opacity.

The control of the number of crystallites is the basis of successful manufacture of zirconium enamels, as controlling the number of crystallites also controls their size. The ideal condition is to have the maximum number of small particles recrystallized to give the maximum opacity.

However, the relationship of scattering power with particle size is not a straight line function but passes through a maximum at a definite particle size. Clewell[6] showed that for very large particles, the scattering power is caused by the reflectance at the particle surface and the surface is proportional to 1/d where d is the diameter of the particle. This means that the reflectance increases as the particles become finer. He also showed that for very fine particles, the scattering power is proportional to d^3/λ_4 where λ is the wave length of light. This means that for very small particles the reflectance increases as the particle size increases so there must obviously be a maximum.

For visual light it can be shown the " Fine pigments of high refractive index whose size is in the region of $\lambda/_2$ possess the maximum scattering power " (Clewell[6]). Thus it would seem that the ideal particle size is about 0.2 μ

In order to obtain a large number of crystallites and to control their size so that they are mostly in the 0.2—0.3 μ range it is necessary to consider a number of factors.

These have been extensively studied for titanium enamels[7][8][9] and these findings can be equally well applied to zirconium oxide opacified enamels.

Von Weirmarn[10] states that the size of particles separating during initial recrystallization, varies directly as the concentration of the saturated solution and inversely as the difference between the concentration of the supersaturated solution and that of the saturated solution under the same conditions. He expresses this as

$$G = K\frac{L}{Q - L} \qquad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

where G = size of particle

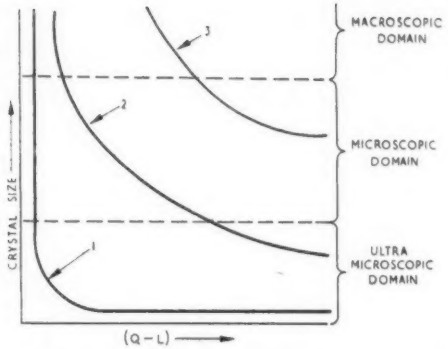


Fig. 1—Curves of the ratio of crystal size to Q - L. (1) has lowest value for L ; (3) has highest value for L.

L = concentration of the saturated solution
Q = concentration of the supersaturated solution
K = is a constant

As can be seen, theoretically large numbers of small crystals are obtained when L is small and Q is large and the curves in Fig. 1 demonstrate this fact.

This equation applies to an ideal case and is limited in application as the rate of crystal growth and consequently crystal size also depends upon the viscosity of the melt. According to Faumann[11] this can be illustrated by the set of curves shown on Fig. 2.

The melt will start to crystallize out at temperature A and as the temperature is reduced to B the rate of growth will increase rapidly as shown. However, as the viscosity of the melt increases the rate of growth will decrease as it becomes more difficult for the atoms to migrate to the already formed nuclei. As the temperature continues to decrease and consequently L is reduced and Q−L is increased (equation 1) then new nuclei appear. This increases until temperature C is reached, the size of particle being formed reducing, and the rate of formation of new nuclei increasing. As the viscosity becomes very high it eventually affects even the initial formation of nuclei and so the rate of formation of new nuclei decreases rapidly.

These diagrams of Faumann[11] are most illuminating, and help to visualize the recrystallization phenomenon. However, in zirconium enamels, the glass is usually rapidly cooled from 1250°C by quenching in water so that very little recrystallization occurs. During the firing process the reverse of Faumann's curves takes place.

The glass has a very low L value and a very high Q−L value so that the particles tend to be very small. In addition the glass is being heated and starts with a very high viscosity so that a very large number of nuclei are formed and the rate of formation is very great. As the temperature increases Q−L decreases and the nuclei tend to grow and the viscosity of the melt decreases allowing easier migration of the atoms to the already formed nuclei.

The removal of the zirconium compounds from the melt further decreases the viscosity and so accelerates the rate of crystal growth.

The size of the crystallite is also important from the point of view of colour. It has been shown that, both for zirconium enamels[4] and titanium enamels[9] very small crystallites will produce pronounced blue tones. This can be seen by underfiring a zirconium enamel when the blue colour is usually obtained.

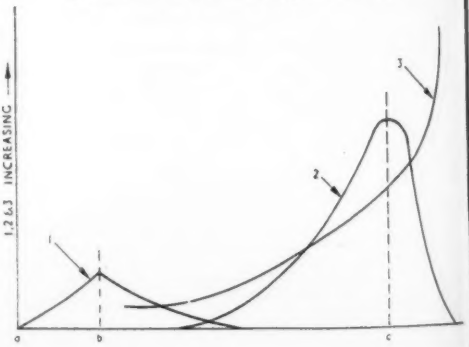
There are many other factors which influence the precipitation of zirconium oxide and which are only imperfectly understood. The enamels are complex formulations and the functions of the various constituents and their effects on the rate of formation of nuclei are only known empirically. Also, it is not only zirconium oxide which recrystallizes from the melt, so the subject is further complicated by a verying melt composition. More will be said of this later in the paper.

Formulation.

From the theoretical aspect it has been shown that to obtain ideal recrystallization it is necessary to have a melt which will dissolve a large amount of zirconium oxide at melting temperatures and only a small amount at fusing temperatures. In addition, the melt should be sufficiently fluid at fluid temperatures to allow precipitation to occur readily and to allow the crystallites to grow to the desired size.

However, the preparation of a very opaque enamel is only part of the problem as the enamel must also have good gloss, good resistance, good

Fig. 2—Curves showing that crystal size depends also on the viscosity of the melt. (1) = rate of crystal growth; (2) = number of nuclei ; (3) = viscosity.



workability, a correct expansion range and as low a "strain point" as possible.

King and Andrews[4][5] reported the solubility of zirconium oxide in typical enamels to be reduced by additions of alumina, zinc oxide and magnesia whereas calcium oxide and barium oxide slightly increase the solubility. All these compounds gave roughly proportionate results at 1250°C or 850°C. They also gave an empirical method for calculating the solubility of zirconium oxide in a melt.

Alumina has a very marked effect on the solubility of zirconium oxide. Although alumina is normally a very refractory material and will increase the viscosity of a melt, in the case of zirconium enamels it can reduce the solubility of zirconium oxide to such an extent that the net result is a more fluid saturated melt.

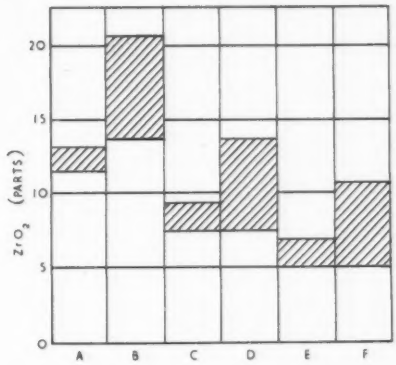
Zinc oxide behaves similarly but of course is not so refractory and does not harden the glass as does alumina. In this respect it is a most useful constituent of zirconium opacified enamels, particularly bath enamels. Its use is, however, limited by its high cost.

Barium oxide or carbonate is rarely used in zirconium enamels as a flux excepting for special applications such as resistant enamels. The reason for this is its toxicity, as zirconium enamels can be made without the use of toxic materials and this is a very important sales point in the dry process industry.

These compounds mentioned above all influence the solubility of the zirconium oxide. For fixed proportions of these compounds, the zirconium oxide solubility is otherwise roughly proportional to the alkali content. King and Andrews[4][5] report that the potassium oxide content has less effect on the solubility of zirconium oxide than has sodium oxide. However, in the modern range of dry process enamels investigated by the author this does not seem to be applicable as molecular substitutions of potassium oxide and lithium oxide for sodium oxide had very little effect on the solubility of the zirconium oxide, although they made a noticeable difference to the fluidity.

Fluorine is the most important element affecting the zirconia solubility in an enamel glass. The other compounds mentioned alter the solubility but they do not behave as does fluorine. The presence of fluorine slightly increases the solubility of zirconium oxide at enamelling temperatures (850°C) but greatly increases it at smelting temperatures (1250°C).

King and Andrews[4] represented this diagrammatically as shown in Fig. 3. It is clearly shown that while zinc and alumina greatly reduce the solubility, the presence of fluorine greatly alters the difference in solubility between the two



Na_2O B_2O_3 SiO_2	100	90	90	80	80	70
CaF_2	–	10	–	10	–	10
Al_2O_3	–	–	10	10	10	10
ZnO	–	–	–	–	10	10

Fig. 3—Diagram illustrating effect of fluorine on solubility of zirconium oxide

temperatures. It is the presence of large amounts of fluorine in the batch which gives the high opacity experienced in modern zirconium enamels.

The physical mechanism of this phenomenon is imperfectly understood but some explanation can be advanced. At melting temperatures the presence of fluorine greatly increases the solubility of the zirconium oxide and at lower temperatures some fluorine comes out of solution. High fluorine glasses usually produce opalescent glasses at lower temperatures due to the crystallization of calcium fluoride. It is believed that some of the zirconium oxide is associated with fluoride in the glass net-work and the removal of the fluorine so disrupts the network that zirconium oxide crystallizes out to enable the glass to maintain a stable structure. X-ray analysis always shows fluorine as calcium fluoride associated with the recrystallized zirconium oxide.

The presence of large amounts of fluorine means that high concentrations of zirconium oxide have to be used and this in turn means a very refractory glass. The addition of alumina and zinc oxide helps to reduce the solubility but the result is still a very hard enamel unless the silica is reduced. The silica content of zirconium enamels is very low as compared with other types of enamel.

Zirconium glasses with high silica contents are manufactured as pottery glaze frits maturing at temperatures much higher than vitreous enamels, particularly bath enamels. The low silica content is a disadvantage in wet-process enamels but not necessarily so in dry-process enamels where high acid resistance is not so necessary. The main difference in formulation between sheet-iron or cast-iron wet-process enamels and bath enamels

lies in the fluorine and the zinc oxide content. The lower fluorine and the much higher zinc oxide concentrations of bath enamels make them much softer and more fusible than wet-process enamels. This is necessary for successful application.

In dry-process enamels the alkali oxides are usually more varied to give a wider melting range and a lower " strain point " for the same working fluidity. If a mixture of sodium, potassium and lithium oxides are used rather than sodium oxide alone, then bonds of widely varying strength are present in the network and give more gradual softening.

The use of mixed alkalis and high zinc oxide content greatly increase the raw material cost of the enamel and offset the relative cheapness of zirconium oxide compounds as compared with antimony oxide.

Compositions of three typical zirconium oxide opacified glasses are given in Table I. A is a wet process enamel firing at 820°C and B is a bath enamel while C is a semi-acid-resisting enamel. The differences in compostions which have been discussed are illustrated in these three enamels.

Table I

	A Wet process	B Bath enamel	C Semi-acid-resisting
Na_2O	12.2	8.7	9.30
K_2O	2.7	5.0	—
Li_2O	—	—	0.75
B_2O_3	12.5	14.1	9.71
SiO_2	30.6	25.6	45.00
Al_2O_3	8.2	8.1	3.46
CaO	4.7	4.1	—
ZnO	2.6	14.1	5.56
P_2O_5	2.1	—	5.89
ZrO_2	12.9	11.0	15.40
F_2*	11.5	9.3	2.51
BaO	—	—	2.15
	100.0	100.0	99.73

*Fluorine is calculated as though there was no loss during melting. In the finished enamel there is only about 25 per cent of the original fluorine.

Manufacture of Bath Enamels.

The manufacture of zirconium bath enamels does not differ very much from that of antimony enamels except in slight variations of technique. The raw materials must be of good and consistent quality and free from those compounds which might discolour the finished glass. Iron oxide is the most common impurity which is likely to detract from the good white colour of the bath powder.

Borax, boric acid, sodium nitrate, zinc oxide, sodium silicofluoride and zirconium oxide are all readily obtained very pure or at least free from harmful impurities. Felspar, quartz, zircon sand, china clay and fluorspar are all obtainable in varying grades and require careful checking before use.

Zircon sand is very much cheaper than prepared zirconium oxide and can be used in the manufacture of bath enamels. It is usually contaminated with impurities such as illiminite. The total iron content should be as low as possible if the best colour is to be obtained. The presence of chromium oxide in the zircon sand is not as serious as it would be for titanium enamels but it does develop a slight green tint to the glass.

If zircon sand is used then the bath mixing must be exceptionally thorough in order to help the rapid solution of this refractory material. If ground zircon sand is used then the mixing is much less critical.

From the foregoing considerations it is obvious that the fluorine content of the finished enamel is fairly critical and this is found to be true in practice. If it is too high, then insufficient crystallization takes place and if it is too low then some of the zirconium oxide is left undissolved.

For this reason, as much fluorine as possible is introduced as fluorspar which is a relatively stable compound. However, it is almost always necessary to use some sodium silicofluoride which is easily decomposed at melting temperatures.

The melting technique is designed to retain as much fluorine as possible consistent with obtaining reproduceable results. The usual method is to melt as quickly as possible with a minimum of agitation and to tap off the glass as soon as the melt is quiescent and free from undissolved refractory materials. The technique means that high temperatures and short times are preferable to the slow, low temperature melting which gives maximum opacity to antimony enamels.

The glass does not reach equilibrium at melting temperatures as fumes of fluorine compounds are still being evolved when the melt is tapped. If the enamel is allowed to soak at melting temperatures then excessive fluorine loss occurs and heavy zirconium oxide recrystallizes out in the melting furnace. This settles to a viscous mass on the bottom of the furnace and apart from being a loss of materials it can put a melting furnace prematurely out of commission.

The rotary melter gives excellent results in melting zirconium enamels as the very rapid solution and the smaller exposed surface area helps to give most consistent results. The flat melter, however, has other advantages.

The presence of moisture either in hydrated raw materials or mechanically entrapped water in the mix can seriously influence the final result. Even stable fluorides react with water at high temperatures and an excessive loss of fluorine can result. Before this was properly appreciated there were many unexplained disappointments

in the author's experience which were later shown to be due to leaving overnight a batch containing hygroscopic raw materials, in a damp atmosphere.

Quenching and drying present no unusual difficulties. As the melt is very fluid, it breaks up very easily in the water. As a rather large amount of salts is dissolved in the quench water, the frit should br swilled with running water unless it is to be dried centrifugally. To neglect this precaution may result in a loss of gloss.

Batch or continuous mills can be used for grinding and the process does not vary very much from that for antimony enamels. The fineness is more dependent upon the application methods used than upon the properties of the enamel glass. However, the gloss and opacity of zirconium enamels always seem to improve with very fine grinding so the powder should be as fine as possible.

Properties of Zirconium Enamels.

Due to their unusual composition, zirconium enamels differ in many ways from antimony enamels.

The first important difference depends upon the fact that zirconium enamels are opacified by recrystallization where as in antimony enamels the opacifier is suspended in the enamel. This gives the zirconium enamel a very high covering power and enables thinner coatings to be used, and blemishes to be much less noticeable. Uneven coatings or thin sections are much less obvious.

After precipitation the zirconium enamels are very fluid and run out nicely but generally they have a shorter melting range than the very soft antimony enamels. The most modern enamels are much improved in this respect and consequently have much better crazing/chipping characteristics.

Another important property depends upon the fact that zirconium oxide is very stable and does not alter at high temperatures. This means that a consistent good colour is obtained and in this respect they are as good as antimony enamels. It is usually necessary to add rather stronger colouring oxides to tint zirconium enamels because of the very high opacity but this extra cost can be countered by the thinner coatings which are used. The inert zirconium oxide does not react with colouring oxides as does titanium oxide so that stable results are usually obtained. Also, special zirconium enamels for strong colours can be made. In these enamels the precipitation is deliberately limited so that bright colours can be used and the good covering power associated with zirconium enamels can be maintained.

One of the most important properties of zirconium enamels is that, with the exception of fluorine, they need not contain toxic materials. In this respect they are less hazardous in use and in manufacture than are antimony or lead enamels. This is the reason why barium oxide is seldom incorporated in the batch when it would otherwise contribute very desirable properties to the glass and could to some extent replace the more expensive zinc oxide. It should, however, be emphasized that bath powder is a ground glass, is fairly soluble in the acid juices of the stomach and still presents a health hazard unless proper precautions are taken.

Zirconium enamels can be formulated to give a wide range of glasses of differing coefficients of thermal expansion and what is more important it is possible to mix high and low expansion enamels at the mill without any serious loss in gloss. With lead-free antimony enamels this procedure often results in surface deterioration. The actual thermal expansion of the glass is less important to the enameller than the melting range or " strain point ". That is to say that with low " strain point " or long melting range enamels, the expansion is much less critical. Thus a wide range of castings and shapes can be enamelled with the same enamel. The mixing of frits at the mill helps to produce this type of enamel.

Research is being directed to produce enamels with characteristics more like the older lead enamels where expansion was not considered important. This is coupled with the development of acid-resisting zirconium enamels which are not now considered the impossibility that they were a few years ago.

As recrystallized zirconium oxide is inert, zirconium enamels also lend themselves very readily to fritted colours, and in this respect there is a much wider palette available than with titanium enamels. Fritted colours offer several advantages to the bath enameller. They are very stable, they are less expensive to use and they completely remove the separation effect often found when dusting milled colours.

The very high opacity of zirconium enamels helps to reduce the dirt problem. Although this may be either an application or a manufacturing fault, it is one with which every bath enameller is familiar, and any enamel, which helps to minimize the effect of dirt, is a big step forward.

Zirconium enamels also have their disadvantages. From an economic point of view, the most serious is the difficulty experienced in remelting waste enamel.

Clean waste powder can be remelted successfully but the procedure is complicated. It could be used by those manufacturers who make enamels for their own use but it presents almost impossible difficulties for the supplier. The main difficulty lies in the fact that the fluorine lost during the remelting process must be compensated for. This can be done by adding fluorine compounds to the powder but in order to melt-in the fluorine

without excessive loss, it is necessary to add comparatively large proportions of other batch materials. In order to reprocess one ton of waste bath enamel it may be necessary to produce two tons of remelted frit. When it is realised that the waste enamel may reach 15 per cent of the virgin powder used and when it is known that the final enamel is not up to the standard of virgin enamel then the economics show the process to be inoperable. However, for enamellers who make their own enamel and who have a competent control department, some savings can be shown.

Another disadvantage of zirconium enamels is their very poor acid resistance but this is countered to some extent by their comparatively good alkali resistance. Until recently, only empirical rules existed for determining the formulation of acid-resisting or alkali-resisting enamels. Recent research, however, has shown that acids usually attack the glass through "holes" in the glass network. The "holes" are occupied by the non-glass forming elements or modifiers such as sodium etc. Alkalies, on the other hand, seem to attack at the bridging O atoms in the Si-O-Si linkages. It is possibly the very low silica content which gives the zirconium enamels their good alkali resistance. Fortunately, alkali resistance seems to be more important to the bath enameller than does acid resistance, but the demand for acid resistance is growing and research into acid-resisting enamels is proceeding. They can be manufactured for use at high temperatures e.g. as glazes, and at low temperatures if lead and barium oxides are used. This research is not yet at the stage where trouble-free enamels can be produced.

Conclusion.

It is hoped that this paper has given the enameller a more complete picture of the zirconium bath enamels and their method of formulation and manufacture. There are still too many unknown quantities which require elucidation and very few facilities for investigation into the fundamentals. Knowledge is growing daily, however, and further developments are quite probable. Soft zirconium dip powders and semi-acid-resisting enamels seem to be the range at the moment but even this is a great step forward from the range offered 10 years ago. The characteristics of zirconium enamels should make further development well worth while.

In conclusion, the author would like to express his gratitude to the directors of Wengers Ltd. for permission to present this paper.

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Discussion

MR. BIDDULPH said that individually zirconium enamels had made a tremendous difference in bath enamelling. The fact that probably half of the white baths enamelled in this country used zirconium enamel was an indication of the extent to which it had been introduced. Particularly as an alkali-resisting finish it had very great advantages. No doubt within the next year or two further developments would be reported.

MR. MILLER asked whether the author could provide details of the alkali resistance of zirconium enamel ? Also when zirconium recrystallized was there a limited amount of oxide ?

MR. ROSS said that in general the alkali resistance of zirconium enamel compared with antimony enamels was superior although a wider range of antimony enamels was available. The zirconium enamel had a low silicon content. With antimony enamels there was quite a wide variation of composition and therefore in resistance. So far as the recrystallization was concerned it was almost always boric oxide which came out of solution; it was always associated with fluorine content. Sometimes silica crystallized out. There had also been several unassessable phases noted at different times. Basic zirconium could be crystallized out. In the earlier enamels there were particles of it in the glass, and in some modern enamels zirconium was sealed in the glass. Invariably this was due to the fact that there was some zirconium sand there which had not been dissolved. It could usually be detected by the fact that the crystallites were very much larger than the crystallized material. The percentage of zirconium silicate was the same as before the firing. He did not think any zirconium silicate came out, but there was quite a combination between the fluorspar which came out as zirconium oxide and, as he had said, there had been several unidentifiable phases.

MR. MURDOCH said that it had taken many years to produce any real advance in zirconium enamel technology. With regard to acid resistance

of zirconium enamels, it had been his experience that it was possible to obtain a very high degree of acid resistance with them. But it did seem that the higher the degree of acid resistance then the lower the degree of alkali resistance. He was inclined to agree with the report that as far as dry-process enamels were concerned probably alkali resistance was more important. Many times Mr. Ross mentioned fluorine and what an important part it played. It did seem now that with this type of enamel it was possible to obtain a covering power which was far superior to that of the antimony type of enamels, using a very much thinner coating. But at the moment it was necessary to use thick coatings, a coating of enamel which was probably the same as the old antimony enamel, in order to get smoothness. Probably the dry-process enamellers could save themselves a lot of money by obtaining castings which had a much smoother finish.

MR. ROSS replying said that in the early days of zirconium enamels an attempt was made to enamel at a very low expansion, and the conditions were found to be reversed. In application the same thing applied to zirconium enamels as applied to titanium enamels a good number of years ago. The covering power was much greater than the actual bath enameller knew with the present enamels. A smooth casting would mean that he could use rather less. He did not agree that it was entirely the casting which was the cause of the trouble ; he thought that some of it was technical as well. In order to get a smooth coating it was necessary to put quite a large amount on. He thought that some attention to the technique of application would, or should, effect some economy. After all, in the early days of titanium enamelling, titanium enamel would cover quite completely at two thousandths, but it was a good many years before people could successfully apply titanium enamels to get the full advantage from their very great covering power. Zirconium enamels were in rather a similar position to-day ; a good many enamellers were not getting the full benefit from them, partly because they were being applied in the same way as antimony enamels. He thought that some attention to application, some improvement in methods and possibly improvement in equipment could be made. However, it would not be good policy to reduce the amount of zirconium bath powder used.

MR. WEBSTER said that Mr. Ross had referred to the evolution of fluorine in relation to the manufacture of enamels. How successful had manufacturers been in dealing with the evolution of fluorine from the point of view of (a) operation, and (b), of the surroundings. All knew what happened a few years ago when a fair amount of fluorine escape took place. He mentioned this because it was one reason the makers of enamels had been so far so shy of making zirconium enamels. What method was used for measuring the resistance to alkali ?

MR. ROSS said that he had been involved with fluorine troubles for many years. There was very little hazard to the operator in the actual manufacture of zirconium enamels because all the fluorine in a normal furnace, unless it was an exceptionally badly designed furnace, went out in the back gases. In the quenching process a small amount of fluorine came up from the quenching water, but in his opinion the amount was quite insignificant. These particular enamels needed practically no raking when quenching. They broke up very easily, so there was no need for a man to have his face in the steam all the time. The actual fluorine evolved from stock was a different problem. Scrubbing equipment was, however, available, which removed most of the fluorine, but it was an expensive piece of equipment.

Alkali Test

The alkali test needed a great deal of consideration. He had spoken to quite a number of bath enamellers and most of them seemed to have their own alkali tests. In general, however, everyone had the same basic idea which was to test it with a hot alkali. The ideal temperature was about 80°C. he thought. He used a straight alkali such as soda ash in a 10 per cent. solution and then measured the loss in gloss over a set time. However, it had been reported that some enamels showed no alkali resistance to soda ash, and the general results were reversed. He was rather at a loss to explain this.

Generally speaking any alkali that was consistent would classify them in particular order. But he felt that a test rather different to the British Standard test of 1944 used generally in the trade would be a big advantage both to the bath manufacturer and to the frit manufacturer.

MR. G. WEBSTER asked whether the Clean Air Act would make it incumbent on manufacturers to instal some form of washing plant and dissuade the small manufacturer from making an enamel ? Presumably zircon enamel would not generally be suitable for use with cast iron domestic sinks due to the acid and alkali resistance, and how critical is the temperature of fusion of this enamel in the bath enamelling ? The problem of the re-melting difficulties was obviously going to put frits out altogether, and was that going to have an effect on the sales ?

MR. ROSS said that re-melting was something which only concerned the manufacturer. He did not think the practice of buying back waste material was in force now, although it was at one time.

(*Continued in page* 280)

DEVELOPMENTS in STEEL SHOT and its APPLICATIONS to VITREOUS ENAMELLING

by D. W. S. HURST and J. BRADSHAW

(*A paper presented at the Annual Conference of the Institute of Vitreous Enamellers, Gleneagles, June* 16 *to* 18, 1958).

IN this paper it is the intention to describe the first major development in metallic abrasives that has occurred in this country for over 20 years, *i.e.*, the introduction of steel shot and steel grit known by their trade names, " Wheelabrator " steel shot and Steeletts. These metallic abrasives are, in fact, genuine steel and the abrasives which have been ordered and used in this country in the past have always been manufactured from chilled cast iron.

The authors' company are not enamellers but through the work undertaken do have the opportunity to see the broad field including the enamelling trade and it is hoped that the facts and information to be presented will be of interest and value. It is proposed first to deal with the manufacture of " Wheelabrator " steel shot and Steeletts, second, to outline the development and practise in shot-blasting machinery, and, finally, to give some practical information regarding the application of this type of abrasive to the vitreous-enamelling industry.

Chilled cast-iron abrasives are extremely hard but at the same time this intense hardness is accompanied by brittleness. Their impact resistance can be improved greatly by heat-treatment processes but the resulting abrasive then becomes so soft as to be of little use to those engaged in vitreous enamelling. Years of experience in the field of metallic abrasives have resulted in the development of " Wheelabrator " steel shot. This experience led to the following conclusions. An effective metallic abrasive must possess certain fundamental qualities. These are :—

1. High hardness.
2. Good resilience and impact resistance.
3. Good wear-resisting properties.
4. Freedom from cracks and unsoundness.

None of the cast abrasives manufactured in this country five years ago fulfilled all these vital requirements, but continuous research, both in the laboratory and by field trials showed that the best possible combination of these properties was obtained from a steel shot having a composition similar to high-carbon, silico-manganese spring steel. Steel of this composition and quality cannot be made in a cupola but requires the electric-furnace steel-making technique.

Ordinary cast-iron shot is produced from a cupola, by disintegrating the stream of molten metal and chilling it in a tank of water followed by a drying process and grading. Cast-iron angular grit is made by taking the chilled material and subsequently crushing it in ball mills and roll crushers. Again this is then graded, producing the range of commercial sizes which have been familar for a number of years, only being interrupted by the last war.

" Wheelabrator " steel shot and Steeletts, have the same beginnings in their manufacture, but only metallurgical knowledge and control backed by skilful electric-furnace practice can produce the high-quality steel necessary to make them.

Once again the molten metal, live steel, is disintegrated in such a manner as to form round shot which is immediately quenched in cold water. After recovery from the water it is dried and cleaned. The cleaning operations are of great importance and are designed to remove all traces of slag, iron oxide and as far as possible unsound particles. In order to obtain the toughness required to give the shot its resilience and impact resistance the material has to undergo a double heat-treatment process. A high-temperature heat-treatment process followed by severe quenching gives the shot a homogenous fully-quenched martensitic structure. In order to carry out this type of heat treatment specially designed and built furnaces are used. Following this treatment the shot is then tempered in a similar-type furnace, resulting in the materiai having a hardness value in the range 420 to 480 Vickers Pyramid Number. The final operation is that of grading and packing ready for dispatch.

The angular form of steel abrasive denoted by the name Steeletts is produced by crushing suitable shot sizes in roll crushers and ball mills. The material for crushing has to be in the fully-hardened condition. Once crushed it is then tempered to give it the same inherent qualities of toughness and resilience as " Wheelabrator " steel shot. This tempering process is designed to produce

the Steeletts with a higher hardness than the "Wheelabrator" steel shot, *viz.* in the range 600 to 700 V.P.N. This is deliberately done to ensure that the abrasive retains its more or less angular form throughout its service life. Again it is carefully graded and finally packed ready for despatch.

The grading of these abrasives is a complete departure from that of chilled cast materials, *i.e.* they are graded to a published specification showing grades and tolerances which ensures consistency in size of this material. The grade symbol and number bear a distinct relationship to the size of the shot and grit, the grade number being the actual size of the aperture of the retaining screen in inches. For example, if the aperture of the retaining screen is 0.055 in., the grade number of the material collected off this screen is called in shot form S.550 and in grit form G.55.

Having produced the abrasives, however, does not complete the story as they still have to carry out their work in industry. It does not follow that by using premium abrasives in the place of cast-iron shot and grit that excellent results can immediately be obtained. Premium abrasives have to be used correctly in order to obtain their full benefits. In today's markets output alone is not good enough as quality and efficiency in producing the end product have an increasingly greater importance. In its context the word efficiency means (a) the quality of the end product and (b) the cost of producing this end product. These are two reasons why premium abrasives must be followed by a high-quality shotblasting process. The shotblasting machine and its technique of operation must be clearly understood by all those concerned with what goes into the machine, and what comes out of it at the other end.

Airless abrasive cleaning equipment, using "Wheelabrator" steel shot and Steeletts, requires a new standard of preventative maintenance and operation. To illustrate this, some of the airless cleaning plants being used in the vitreous-enamelling industry will be described and suggestions made as to these how plants can be brought to a first-class condition and how maximum operational savings can be achieved with minimum maintenance costs.

The first plant designed specially for the preparation of castings prior to vitreous enamelling was the belt-conveyor type. This plant is equipped with two throwing wheels mounted on the flat roof of the cabinet in such a way as to present abrasive blast coverage over the full width of the belt.

One disadvantage which had to be overcome with the use of "Wheelabrator" steel shot on this plant was the increased tendency for warpage to occur. A particle of this type of shot being spherical, is heavier than a particle of chilled iron grit in the same size range, and because of the easy flowing nature of the material it is possible to pass more of this abrasive through the wheel than was possible with chilled iron grit.

Due to the wheels being situated over the belt and discharging directly down on to the castings, it will be appreciated that the weight of the blast stream is considerably increased.

There are two ways of overcoming this problem.

The first and obvious way would be to reduce the weight of the blast coverage by limiting the amount of abrasive fed to the wheels ; the second way is to increase the speed of throughput, thereby reducing the time cycle of the castings in the blast zone.

The authors do not recommend the first way, because a reduction in the amount of abrasive passing through the wheels, also means a reduction in the operating efficiency of the plant. The second method has been proved in practice and operators of this type of plant have found that they can obtain a surface finish on the casting, satisfactory for enamelling, and together with increased production from the plant.

A machine developed initially for gas-cooker manufacturers is the airless multi-table plant. This plant has four 4-ft. diameter tables, each of which begins to spin when approaching the blast area of the two angled wheel units, and rotates many times under the blast pattern, thereby achieving faster and complete cleaning. All the exposed surfaces of the work-pieces receive a uniform blast coverage, and due to this and the fact that the abrasive stream is projected at an angle to the tables, tendency for warpage o n thin-wall castings is considerably reduced.

Another type of table machine which has become popular in the enamelling trade is the plain table type. This machine has a single rotary table fitted in a vestibuled cabinet. Two throwing wheels, angled on the roof of the cabinet provide abrasive coverage of the castings suitable for enamelling, it is often necessary to pass the work through the blast zone a number of times, the operator turning over or re-adjusting the position of the work on each revolution of the table.

The machines described adequately deal with the range of small castings used in the enamelling industry.

The authors consider, however, that the maximum savings that premium abrasives offer are not being obtained.

"Wheelabrator" steel shot leaves the impelling wheel at a much higher velocity than chilled iron grit, and a high percentage of the shot thrown will bounce back and forth between the wheel, work and cabinet interior many times. There is little doubt that this rebounding abrasive contri-

butes as much, if not more, to the wear on the cabinet interior than the actual controlled abrasive blast stream. A programme of preventative maintenance is essential, therefore, before commencing to use premium abrasives in a production line, and the authors strongly recommend the use of hard-metal abrasion-resisting wear places for lining the impellor wheel hoods and parts of the cabinet interior in direct line with the abrasive blast stream.

Experience has proved that rubber curtains offer little resistance to the hard hitting power of premium abrasives, and it is in the plant operators' best interests to consider completely or partially covering the walls and roof of the cabinet with special abrasion-resisting tiles. The comments on rubber curtains apply also to rubber-covered conveyor belts and tables, and it is most important that the belt or table is covered, as far as possible, with castings.

Assuming that the programme of preventative maintenance in respect of hard-metal lining plates and tiles has been carried out and the plant has been charged with a quantity of " Wheelabrator " steel shot, the next problem is to retain the abrasive within the abrasive cycling system. Full benefits and an accurate cost record of producing cleaned castings cannot be obtained if useful abrasive is permitted to escape outside the abrasive system. Therefore, before attempting to compile a cost record of abrasive and replacement parts used, the plant must be put into a first-class operating condition to minimize abrasive losses, which, other than the normal consumption of the plant, may be due to any or all of the following causes :—

(1) Leakage in equipment.
(2) Inefficient abrasive separation.
(3) Carry out.

The cleaning plant should be inspected frequently for leakages, which may occur at the seals around the doors or in parts of the machine which are exposed to the direct blast from the wheel, and which are permitted to wear through. Another source of leaks is the hoppers, especially the main hopper which is usually out of sight and too frequently out of mind. Rubber curtains in the plant vestibules must be kept in a good condition, not only to keep the abrasive in the plant, but to protect workmen from flying abrasive.

Efficient abrasive separation is one of the most important factors to consider in any blast-cleaning operation. The function of the abrasive separator is to remove contaminants from the abrasive cycle ; these contaminants may be sand, scale or pulverized enamel from de-enamelling operations, plus abrasive reduced to the point of being rendered ineffective as a cleaning medium.

When replacing other types of abrasives with " Wheelabrator " steel shot it is most important for the separator to be re-adjusted. It is not possible to describe this operation in this paper, because of the many different types of separating devices in operation, but briefly it is a matter of re-adjusting the air-flow through the air wash.

Anyone having doubts about the efficiency of this unit on his plant should contact the plant manufacturers for advice, as the incorrect setting or malfunctioning of this unit will decrease the overall operating efficiency of the shotblasting process.

Abrasive carry-out is a common cause of high abrasive consumption. An ounce or two of abrasive carried away from the plant in crevices and recessed areas of each casting will add up to a considerable amount at the end of a working shift, and when that abrasive is " Wheelabrator " steel shot it means cleaning costs increased by hundreds of pounds a year.

If the abrasive cannot be returned to the abrasive cycle when the castings are removed from the plant, provision should be made to collect and return the carried-out abrasive from the point of the next operation.

Before cleaning on a production basis, the control cages must be set in order to determine the distribution of the blast stream. " Wheelabrator " steel shot leaves the wheel much sooner in relation to the setting of the control cage aperture than chilled iron grit, and it is therefore necessary to advance the control cage in the direction of rotation of the wheel. Periodic checks on the pattern of the abrasive distribution assist in using the blast to its maximum efficiency.

It can now be assumed that the plant is in a first-class operating condition and ready to commence cleaning operations. During the initial running, the rate of abrasive feed should be determined. The feed valve should be opened to a point where maximum abrasive flows through the wheel without building up in the abrasive funnel ; on a standard 19½-in. diameter wheel this usually records approximately 20 amp. on the ammeter.

There is in some cases such a thing as throwing too much abrasive, especially on hollow work where the abrasive may collect in recessed areas and shield the covered surfaces from the impact of the blast stream.

If it is found that successful cleaning can be achieved on a 16-amp. loading, then it is advantageous, because wear on the cabinet interior and replacement parts is proportionate to the amount of abrasive thrown and this will reduce the overall cost of the cleaning operation.

After the first run with the new abrasive, do not be disappointed if the cleaning results fall below expectations. Efficient abrasive operating mixtures should contain large, medium and small particles of abrasive. The operating mixture

formed by the normal wearing down of the abrasive particles and when an efficient operating mixture is attained, cleaning results should be excellent. In order to maintain an efficient operating mixture, it is necessary to make small additions of new abrasive at regular intervals.

The introduction of " Wheelabrator " steel shot with its comparative high initial cost, has served to make plant operators cost-conscious, and the authors' company frequently receive favourable field reports confirming the overall operating savings which premium abrasives offer.

The introduction of premium abrasives in the form of steel shot was not originally thought to be of prime interest to vitreous enamellers. For many years the basis of enamellers' complaints have been concerned with the presence of " half rounds." " split rounds," or even particles of round shot and these have been regarded as undesirable features. Its introduction, however, did not escape notice of the vitreous enameller and it was not long before trials with steel shot were being carried out. The results have clearly shown that " Wheelabrator " steel shot can clean and prepare surfaces which are to be vitreous enamelled. In the case of one large firm of enamellers, parallel tests, on a full-production basis, were run using cast-iron grit and steel shot. The cast-iron grit used was grade 12A, the normal size abrasive used, and the steel shot used was grade S.230. The results of these tests was an increase in the number of successfully enamelled castings. In actual percentages the figures were 82 to 86 per cent good castings using chilled cast iron as opposed to 91 to 94 per cent good castings using " Wheelabrator " steel shot. The most important fact to note is that the steel shot was a much finer grade of abrasive, actually three sizes down the scale. This proves that the shot has remarkable impact and resilience qualities plus a very high coverage of surface area.

To date it would appear that there are certain cases where premium abrasives are not completely successful in cleaning castings prior to enamelling, for example, those castings where it is necessary to add a matt ground coat prior to the enamel. The reason for this would appear to be that a matt ground coat has no chemical bond with the surface of the casting but relies entirely upon a physical bond. The second case is with castings which have areas with heavily " burnt in " sand. These are really bad castings to enamel in any circumstances but " Wheelabrator " steel shot tends to cover over particles of sand in the surface by its peening action. Third, there are the castings which have been stored for considerably long periods having become actually pitted with rust ; the reasons for this are similar to the previous case in that the oxide can be peened over. Finally, with castings which have a very hard surface, possibly due to wrong analysis or chilling effects, the steel shot tends to bounce or glance off without really attacking the surface.

Apart from these exceptions large tonnages of high-quality heavy-duty castings are successfully cleaned with " Wheelabrator " steel shot prior to their general enamelling treatment of one enamel coat, underglaze enamel coat and annealing grip coat plus enamel coat.

Due to its toughness and resilience steel-shot cleaning leaves the surface of a cleaned casting relatively free from dust, a fact which is easily proved by a finger test, which with a casting cleaned with steel shot reveals little trace of metallic deposit. It is thought by some enamellers that this fact explains the reason for the drop in the number of rejected enamelled castings through " boiling " defects.

Steel shot is also used extensively for de-enamelling and experience has shown that the cleaning time has been reduced due to the very high coverage which appears to " shatter " the enamel coat as opposed to the " cracking " that takes place with a larger grade chilled cast-iron abrasive.

Future developments using the cleaning power of premium abrasives undoubtedly lie in the field of steel sheet. Already in the steel industry of today continuous steel strip and steel sheet are being cleaned by " Wheelabrator " steel shot blasting, in special airless-type machines, replacing messy and slow pickling operations. The authors suggest that eventually the enamelling industry will find advantages in investigating the use of premium abrasives for this application.

Acknowledgements

The authors thank the directors of Bradleys (Darlaston) Ltd. for permission to publish this paper and Tilghman's Ltd. for assistance in its preparation.

Discussion

MR. WATTERS referred to the economy of sand-blasting and said he was sorry the author had not referred to it for bath enamelling plant. He would like to have the author's experience with bath enamelling using steel shot. Many people had used steel shot but had reverted back to cast iron, not because of the cost but because of heavy breakage. Annealed cast-iron shot had been introduced to reduce this.

MR. HURST said that there had not been a considerable amount of success with the cleaning of baths. He was not familiar with it as an enameller, but he did know, of course, that the

(*Continued in page* 280)

Developments in Steel Shot

(*Continued from page 279*)

enamel was applied to baths in a very different way to cookers, etc. He was careful to say at the end that each case had to be dealt with individually, because everyone had certain factors, whether it be in plan or technique, which would make the use of steel shot or Steeletts different in operation. Personally he could not see any reason at all why steel shot or Steeletts could not be used for the cleaning of baths prior to enamelling.

As regards breakage of steel shot, it was true to say that many plants were so designed that the force at which the abrasive hit the casting was very much greater than it was with cast iron. Some thought had been given, and action was being taken, to advising people on the type of abrasive to use in the plant. If the plant was of such a nature that they could not use steel shot because of breakage then there was no solution. But if the plant was a conveyor type, then the method of speeding up the belt stopped breakage and warping. Annealed cast-iron shot had been on the market for some considerable time ; annealing reduced the hardness so giving a very soft abrasive. It was a question of whether that soft abrasive cleaned the work quickly enough, and, also whether it cleaned it efficiently in the time, as to whether it was the better and cheaper abrasive to use. On the other hand all-steel shot had brought about a complete changeover in the operation of Wheelabrator plants etc. Whether malleable or annealed cast-iron shot was as good as steel shot was a question of cost and time, and each individual case had its own peculiarities.

MR. WEBSTER said his company was possibly one of the first to try the Steeletts but they were not successful as they broke up into powder very quickly. They tried steel shot fairly extensively, and obtained extensive wear and tear, both in cleaning square castings and in trying to strip enamelled castings. The wear and tear on the Wheelabrator, of course, was considerably less. Everything became polished. It gave a much higher velocity to the shot, and did tend to damage thin edges on the castings.

MR. HURST said that possibly the Steeletts used were not up to quality. The annealing of the crushed steel material had to be kept separate from the Wheelabrator steel shot. It was only recently within the last two or three weeks, that it had been possible really to say that these materials were consistent in each particular pack.

As regards edges on castings this only emphasized the character of the steel shot itself, in that it did have very high resilience, causing ricocheting, and it was quite true that very fine edges could become damaged. Each case had to be treated on its merits ; it was a long, painstaking job to decide the type of abrasive, but this was modern practice.

MR. WATTERS asked what type of grit would the author recommend for a Wheelabrator sandblast for cleaning castings for cookers.

MR. HURST said that the most successful grit, generally speaking, would be of the S.230 range, the range mentioned in the paper, as being suitable for cleaning cooker castings. But it did depend individually entirely on the plant to be used and the method in which the castings were put in, etc.

All the work done in a Wheelabrator was not done by one particular size of abrasive. He was emphasizing that ; the cast iron material very quickly broke down, therefore, if fresh material was put into the machine, S.230 in this case, it was quite true to say that probably the best results would not be obtained until the abrasive had worn to produce a " mixed " pack, and fresh steel shot was added.

Zirconium Bath Enamels

(*Continued from page 275*)

The manufacturer could however, use remelt material in the same way as for antimony enamels, *i.e.*, frits that came back from the melting shop could be put back into production *via* the melting furnace. But he did not think that influenced the price of bath powder at all. Antimony was very expensive, and zircon very cheap. But the selling price was almost the same. In general, however, the price of zirconium powders was cheaper than those of antimony. There was a big field for reducing the cost of zirconium enamels because of the zinc content. The zinc content in Table I of the paper was 14 per cent. in the bath enamel quoted. Actually there had been quite a big drop in that in the past two years, and a corresponding price decrease. He had mentioned costs in the paper but had left reference to them out when he was introducing it through for the sake of time. As regards the Clean Air Bill, he was not very familiar with it, and did not know how far it affected the fume from the chimney. He did not think the evolution of fluorine in an industrial area presented a real health hazard to the surrounding people. The biggest effect it had was in etching windows. No doubt scrubbing equipment was the ideal solution but he knew of more than one place where zircon enamels had not been manufactured just for that reason. It was possible however, to reduce the fluorine content. He had seen recently glazes which had been made without fluorine at all, and had correspondingly a very high acid resistance and a very high alkali resistance. Fluorine had a very marked effect on the resistance of both acid and alkali.

FINISHING NEWS REVIEW

ALLOY FOR CHROME PLATING

A NEW lead alloy developed by British Lead Mills Ltd., "Antac R.1" has been designed to counteract a small but increasing number of inexplicable failures in chrome tank linings. During development, over two hundred different alloys were made up and tested; and of these the most promising were put in small pilot plants under rigorous conditions.

It was found that the newly introduced alloy was the only one not attacked by chrome plating solutions even when all the accepted rules for the protection of linings were deliberately broken, e.g., reversals of current, standing for months in cold solution, boiling away the solution, the addition of impurities, and other abrises.

The lead alloy is now available in the form of sheet for linings, pipe for heating and cooling coils, and anodes. Its introduction will dovetail with technical advances made by the industry over the last few years, including speed of plating, hardness of deposit, and non-porosity. Antatac R.1 Lead Alloy is in use in Vauxhall Motor's new plating plant at Luton.

British Lead Mills Ltd., of Byron House, 7, 8 & 9, St. James's Street, London, S.W.1 is a member of the Firth Cleveland Group.

NICKEL PLATING PROCESS

U.S. Development Introduced to U.K.

From the first of this month, Albright and Wilson (Mfg) Ltd., are marketing a new process for bright nickel plating. Orginally developed in the United States by the Hanson-Van Winkle-Munning Co., where it is know as "Nickel-Lume," and "Levelume," Albright and Wilson have applied for registration of the name "Plusbrite" for the new process.

Claimed to be completely new to the U.K. the process combines with a fully bright finish better physical properties of the plate than have hitherto been available here. A. and W. say that it offers considerable scope in the motor vehicle industry, for example, for plating accessories such as bumpers and over-riders where a high standard of brightness and serviceability is required. The process should also find many uses in the plating of electrical appliances, steel pressings, forgings and zinc-based die castings, as well as brass and copper parts.

Major advantages claimed for the new process are the excellent levelling properties provided together with the fully bright deposit which has a very good degree of ductility. The deposit is also highly receptive to subsequent chromium plating.

Data sheets are available and further details of the process can be obtained from the Metal Finishing Department, Albright and Wilson (Mfg.) Ltd., 1 Knightsbridge Green, London, S.W.1.

BRIGHT SILVER PROCESS

BRIGHT silver electro-deposits are desirable for many applications including both decorative and industrial finishes and to meet this need the Baker Platinum Division of Engelhard Industries Ltd., 52 High Holborn, London, W.C.1, have recently introduced a bright silver plating process.

The features claimed for the Baker bright silver plating process include the following: mirror bright finish through a complete range from flash to heavy deposit; deposits are hard (V.P.N. 135) and highly ductile; the clear, water-white solution enables the plater to watch work in the process of being plated; organic contaminations can be removed by filtration through activated carbon; and the solution possesses excellent throwing power.

The Baker bright silver solution is a high cyanide bath with special brighteners added.

AGENT FOR THE RAPID DRYING OF METAL ARTICLES

A NEW technique for the rapid drying of metal articles has been introduced by Imperial Chemical Industries. Metal parts are treated in trichloroethylene containing a new additive, "Trisec," that the makers claim, ensures freedom from staining even of bright plated and polished parts.

It is well known that wet metal articles can readily be dried by immersing them in the vapour of a boiling chlorinated solvent, such as trichloroethylene — the solvent used in most I.C.I. degreasing plants. The moisture film will dry off because, although the boiling point of trichloroethylene (87°C.) is below that of water, a mixture of solvent and water boils at an even lower temperature (73°C.). Vapour degreasing plants can therefore be used for drying small metal articles, even though the evaporation of large drops of water from the surface leaves stains. Owing to the risk of staining, such a method is not suitable for bright plated or other polished surfaces.

With the new I.C.I. technique, the idea of using trichloroethylene has been retained, but the treatment is in liquor instead of vapour, and to prevent stains forming on the articles, the special additive, "Trisec," is mixed with the solvent.

"Trisec" has been specially developed to be effective at moderate temperatures so that advantages can be taken of the low heating requirements of trichloroethylene. The effect of the additive is to displace the water film on the metal surface by trichloroethylene, which readily evaporates.

Any article which can be degreased in an I.C.I. liquor-vapour degreasing plant can be dried by using "Trisec," provided that the appropriate type of basket, jig, or other handling equipment is used. As with any drying process, it is necessary to ensure that the work has been well rinsed in clean water before it is introduced into the plant.

The whole process is normally completed in about 1 minute.

The process of drying with "Trisec" is the subject of a British patent application.

ALUMINIUM BARTER DEAL

CANADA and Norway have agreed upon a £71 million aluminium deal whereby over a 20-year period Canada will barter 3,700,000 tons of alumina to two Norwegian owned smelters in return for aluminium ingots. The deal is reported by Barclays Bank D.C.O. from Jamaica where, it says, production of alumina will be stepped up to meet the terms of the deal. Canada has substantial bauxite interests in Jamaica.

ANGLO-GERMAN AGENCY AGREEMENT

AN agreement was signed recently between Short and Mason Ltd., Aneroid Works, 280, Wood Street, London, E.17, and Aktiengessellschaft Chemisches Institut Dr. A. G. Epprecht, Zurich, whereby they will act as sole agents in Great Britain for the range of Drage Instruments. An instrument application department has been set up to advise on the use and installation of instruments that include torsional viscometers and rheometers, and plant assemblies for automatic control of viscosity. The new Drage Multitest tensile, compression and bending test machine will also be available.

PROTECTION OF SHIPS' HULLS

Standard Anode Adopted for Cathodic Protection

WHAT is claimed to be a unique method of combating corrosion on ship's hulls has been developed by Cathodic Corrosion Control, Ltd., a subsidiary of Constructors John Brown Ltd. The company has adapted their standard CX3 line anode for marine work and incorporated it into an automatically controlled cathodic protection

It is well known that properly designed and installed cathodic protection systems can completely eliminate the corrosion of steel in sea water, but to date no truly economical system for a ship's hull has been devised. The electric current requirements to protect a hull vary over a very wide range because of varying factors such as the paint condition, the speed of the ship, and the salinity of the water, for example.

The ideal system is one which plates out a thin calcareous film on the bare spots of the hull as they occur, so keeping the whole surface smooth. If too thick a film is deposited, roughness of the hull, consequently fuel consumption, is increased. If, on the other hand, insufficient current is supplied the surface will corrode and the consequent roughness will again affect the efficiency of the ship.

The CX3 line anodes are available in practically any length and with a wide range of dimensions giving the system an approach to the ideal of an anode encircling the ship. The installation is made easier because long thin anodes are easily attached to the hull structure and only one hull penetration is required for each anode. This type of anode loses only a small amount of current per foot, producing a small voltage stress in its immediate vicinity; consequently, if the paint film is suitable reinforced, no other shield is necessary. The lead alloy will give an almost indefinite life if it is not mechanically damaged.

A method of measuring the potential between the ship's hull and the surrounding water has been developed by the use of the C.C.C. zinc plug reference electrode. The measured voltage from this electrode is supplied to a special transformer/rectifier unit having an output automatically adjusted by an electronically-controlled magnetic amplifier. The unit has two controls, one that can be adjusted from 25-100 per cent of the unit rating, and the other ranging from 0.1 to 0.4 volts, the maintained potential difference between the hull and the electrode. The unit will automatically adjust the current supplied to the anodes so that the whole potential is kept within 10 mV. of the pre-set potential, determined by the position of the zinc electrode and the state of the ships hull.

The system requires an A.C. current supply, but as this is becoming more common in ocean going ships it is not regarded as a difficulty. Installation is comparatively simple. For example, with a unit having a maximum output of 150 amp., one single-core insulated cable of 19/.064-in. copper is taken to an anode on either side of the ship's hull. The anodes might consist of some 30 ft. of extruded 1-in. dia. CX3 lead alloy installed towards the stern.

The zinc reference potential plug is welded into the hull at a point near the stern and connected to the transformer/rectifier unit by a single-core cable. If the ship was laid up at any time, a shore A.C. supply would maintain the underwater hull in perfect condition.

NEW PREMISES

LARGER premises for their Midland Branch office at 162/3 High Street, Deritend, Birmingham 12, have been acquired by M.L. Alkan Ltd., Telephone: Victoria 5315. The additional facilities will improve service for customers in this area.

CLEANING NON-FERROUS METAL TUBES

FACED with the problem of having to clean a weekly total of 150 tons of non-ferrous metal tube, much of it in lengths up to 20 ft., Serck Tubes Ltd., of Birmingham contemplated the introduction of a very large trichlorethylene degreaser that because of space limitations would have proved both difficult and expensive to install.

Their existing method of cleaning used on the tubes had several disadvantages, notably inadequate degreasing inside the tube, subsequent formation of smut on the work, and contamination of other solutions in the cleaning, pickling and passivating line.

Answer to the problem was found by using "Grisiron W.Z" — a product of Roto-Finish Ltd., Hemel Hempstead, Herts. Used in the proportion of 50 gm. per 1. (8 oz. per gal.) the tubes are immersed in the nearly boiling solution for 20 minutes. The quantity of 1,000 gallons is maintained by additions whenever the rate of cleaning appears to be falling. Consumption is 5 to 6 cwt. of cleaning salts monthly, and every 5 or 6 weeks a new solution is made up. The sludge formed by Grisiron is much lighter and so disposal is easier. Increased cost of the material has been offset by a reduced cleaning time and the elimination of hand-wiping after treatment.

Nickel Plating in India

View of the machine showing the nickel plating tank in the foreground and the nickel purification section

WHAT is almost certainly the first automatic machine for bright nickel plating for use in India has been completed by Electro-Chemical Engineering Co. Ltd., in their works at Sheerwater.

The machine, of the Efco-Udylite type, is destined for a leading firm of cycle manufacturers. It is fully-automatic (apart from manual loading and unloading) and the processes include a degreasing and pre-cleaning sequence followed by bright cyanide copper, bright nickel and chromium plating, and a final drying section. In all, 35 different processes including water rinses are provided. The machine is hydraulic in operation.

Overall dimensions are 108 ft. long x 12 ft. wide over tanks, x 13 ft high. Output on three tracks of work continuously passing through is 180 racks per hr. Each work rack is 12 in. x 36 in., a convenient size for handling, and holds work with an effective surface area of over 2 sq. ft.

The plating specification called for a combined deposit of copper, nickel and chromium. A thickness of 0.001 in. copper will be deposited in a bright cyanide copper tank with a capacity of 7,300 gal. and provision has been made to off-load racks that require buffing before bright nickel plating. Subsequent additional cleaning processes are included to remove buffing composition before the racks enter a bright nickel tank that has a capacity of 5,000 gal. The average nickel deposit will be 0.0005 in. using an air-agitated Efco-Udylite solution. A special refrigeration unit has been provided to reduce the temperature of the chromium plating solution.

CAN LINK-UP

THE Continental Can Company Inc. of New York and Vacuum Research (Cambridge) Ltd. of Engoand, have formed a company—Vacuum Metallizing Processes Ltd.—registered in England, for the purpose of promoting and licensing in all territories outside North and South America their jointly developed and patented process for the metallizing in vacuum of plastic films and paper, on a commercial basis.

Vacuum Research (Cambridge) Ltd. has been responsible for the design, construction and installation of production metallizing facilities.

F.B.I. LISBON TRADE FAIR

THE Federation of British Industries has decided that the next British trade fair in its programme of overseas fairs will be held in Lisbon from May 29 to June 14, next year. The fair will be organised by British Overseas Fairs Ltd., subsidiary of the F.B.I. responsible for the organisation of the trade fairs held in Bagndad (1954), Copenhagen (1955) and Helsinki (1957), as well as for the British pavilion at the Damascus International Fair in 1956 and the British Industry Pavilion at the Brussels Universal and International Exhibition. An all-British effort, comparable in size, to the one held in Helsinki. 10,000 copies of a brochure "British Trade Fair Lisbon" have been sent recently to British manufacturers and to agents in Lisbon.

Britain is Portugal's main customer and for many years was her principal supplier until ousted recently, by Germany, who buys comparatively little from Portugal. The time is ripe, feels the F.B.I., for a special endeavour by British industry to regain its position, resulting in a swing of trade to this country of £5-6 million yearly.

The new Exhibition Hall in Lisbon, situated on the river Tagus, will be used, and 125,000 sq. ft. of exhibiting space will be available to exhibitors; including 80,000 square feet in the grounds outside the hall.

The fair will be organised in trade sections, and space will be taken up by U.K. manufacturers or their agents in Portugal. Response to the proposals has so far been very favourable. Buyers from the whole of South West Europe will be encouraged to visit the fair and it is hoped that the events will be broadcast not only on the Portuguese Radio but also on other networks.

In the evenings the outside gardens will be lit up and a number of ambitious and unusual displays will be staged. A full programme of supporting events is envisaged on the pattern of previous British trade fairs.

In 1957, total U.K. imports from Portugal were £16.5m. and U.K. exports to Portugal amounted to £22.3m. Of this amount £0.3m. were made up of pigments, paints, varnishes and related materials, and £0.6m. of manufactures of metals such as holloware, etc. Metal finishers also had a substantial interest in the two largest categories of exports — road vehicles and aircraft.

I.C.I. Paint Division's

Laboratory will provide compre

Next best thing to a personal tour of the new pre has been arranged by I.C.I. Comprising a series of colo slides along with a spoken commentary, the view taken on an "armchair" tour of the laboratories a able to see the work that goes on there. Along wit

A NEW technical service laboratory building has been erected at Slough to provide the paints division of Imperial Chemical Industries Ltd., with facilities for giving a comprehensive technical service to its customers. The service includes advice on painting specifications and techniques of application, demonstrations to customers, and training for painting operatives. Practical trials of new products and new techniques can also be carried out.

Closely linked with the technical service department is the colour advisory department, where advice on the use of colour and colour schemes to suit individual customer's requirements can be given. The new building has been designed as a main single-storey laboratory block with a two-storey administration wing.

All the different sections of technical service at Slough are housed for the first time under one roof. Greatly improved equipment makes it one of the most outstanding paint-service laboratories in this country, if not the world. Technical staff has been greatly augmented during the last few years and has been re-organised under four section heads.

Block Layout

A main block, roughly 210 ft. x 120 ft. in size, houses the various practical sections of the department — pretreatment, industrial, motor manufacturers and refinish, commercial transport, woodfinish, decorative and marine — each in its own separate section of the main building. There is also an oven-room section and a large store-room.

There are two rooms for trainees — one for industrial and transport, and the other for the decorative and marine field. In addition, there is a lecture room that can hold 30 people.

At one end of the building a semi-covered area about 14 ft. deep runs the width of the block, where particularly dirty operations can be carried out without upsetting the cleanliness of the main space.

Pressurized Atmosphere

The main block is brick-built with a single-span roof, ventilated by an air-heating and filtering plan situated in an enclosed gallery runt ning the length of the roof and designed to maintain a slight positive pressure throughout the building. A supply of warm filtered air automatically replaces that drawn from any of the various spray-booths, keeping a constant excess pressure to prevent the entry of unfiltered air.

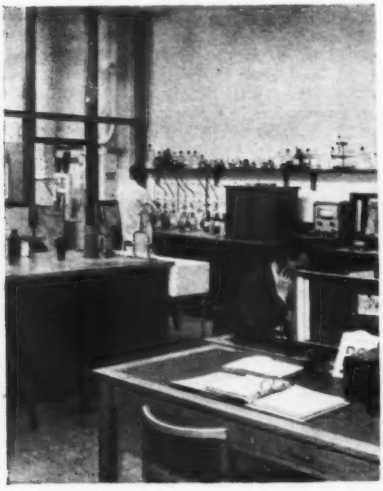
Lighting

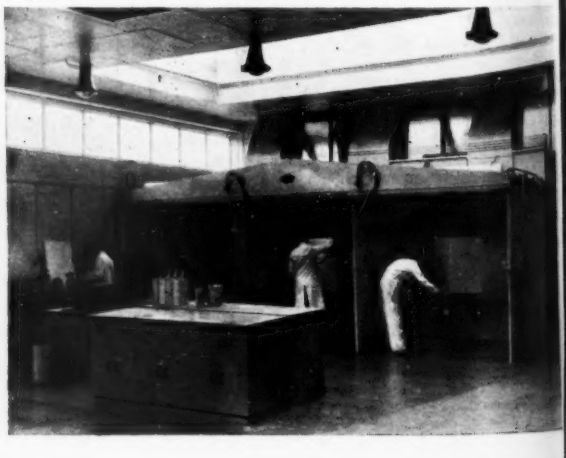
The building is lighted by "monitors" standing proud of the main ceiling and allowing light only through the vertical sides. This gives a mixture of north and south light, rather than the more common north lighting found in factories. For colour matching, a colour-booth in the refinish section uses artificial daylight.

The top half of the exterior of the main laboratory block is in "Kynalok" aluminium cladding that covers the air-conditioning plant and intake filters in the topmost gallery and also forms a "parapet" at the top of the brick walls to hide the ducting from the spray booths and all but the top of the lighting monitors.

Administrative Wing

At the north end of the building, a two-storied wing measuring 100 ft. x 45 ft. has a spectacular studio-light window as its outstanding feature. The ground floor of the wing comprises the entrance hall, a combined reception and show room, and the administrative offices of the department. Upstairs is the colour advisory department, dominated by the enormous north light.





(Left) The metal pretreatment laboratories and (below) water-washed spray booths.

chnical Premises at Slough

ing and training services for customers

ides, the division has made a film, "A Coat of Paint", n full colour that illustrates the service the laboratories re able to offer to users of their products. The film uns for about thirty minutes and is available on loan rom the I.C.I. Film Library at Millbank, London, S.W.1.

An interesting feature is the use of a "Multitone" staff-location system that enables a call received from a customer to be relayed to a representative anywhere in the laboratory.

Technical Service Department

Pretreatment Section

Materials for the preparation of metal before painting constitute an important group of the division's products, and, in the pretreatment section, these materials can be demonstrated.

Trials of new chemical-treatment processes for the cleaning and de-rusting of metal, and subsequent phosphating or other chemical treatment, can be carried out in two tank rooms.

In the larger of the two is a tri-chloroethylene degreasing plant, and tanks containing 'Deoxidine', 'Granodine' and 'Alocrom' processes, mostly heated by steam and thermostatically controlled. There are also two experimental cabinets for spray-applied pretreatments.

The other tank-room contains a number of smaller tanks for experimental work.

Industrial Finishing Section

The industrial finishing section is concerned with the problems relating to the finishing of manufactured goods other than transport vehicles.

The section includes a main application-shop, with separate rooms for flow-coating and electrostatic application, an oven-room with various stoving devices, and a separate room for training purposes.

Main feature of the application-room is a bank of three large water-washed spray booths, covering a total width of 24 ft., with movable dividing partitions.

Hot-spray plants and airless-spray equipment that applies paint at high temperature and at great pressure, (relying on expansion and evaporation to provide atomisation) are available.

For dip-finishing, there is an apparatus that can be adjusted to withdraw articles from a dip-tank at various speeds. There is also a full-sized curtain-coating machine for the very rapid coating of flat or near-flat parts. A separate laboratory houses a flow-coating machine for determining the suitability of a paint for this method.

The electrostatic plant, housed separately includes a mechanical conveyor line that can take panels up to about 3 ft. x 2 ft., and all three methods used in the Ransberg No. 2 process — spinning disc, cone and bells — can be demonstrated.

One end of the oven room is occupied by a hump-backed conveyor oven, gas-fired with variable-speed conveyor. There are two forced-convection box-type ovens, large enough to take a washing machine or a medium-sized refrigerator, also gas-fired. For small work there are a number of electrically-heated laboratory ovens.

The centre of the oven-room is occupied by a rectangular overhead conveyor which passes through three different types of radiant-heat ovens, one electric and two gas-heated, all capable of carrying panels up to about 4 ft. x 2 ft.

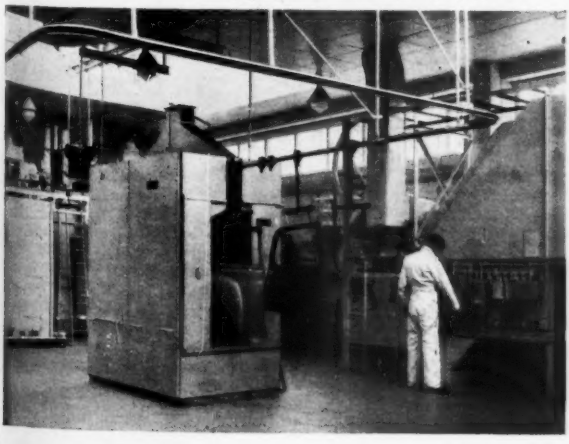
A trainee-room equipped with a large spray-booth offers full facilities for training. A large area is devoted to woodfinishing — mainly concerned with the furniture and radio-cabinet industries.

Transport Section

The section has two separate rooms, the larger containing facilities for finishing a number of motor-cars at one time, if necessary, although much work is carried out on sections of cars such as doors and wings. There is a totally-enclosed unit comprising a spray-booth and oven in which a large motor-car body can be sprayed under completely dust-free conditions and then passed

(*Continued in page* 287)

(*Below*) *The oven room and* (*right*) *an electrostatic spray plant.*



RUHR OFFICE FOR BRITISH INSTRUMENT MAKERS

AS a result of continued expansion in Europe, and to offer the German market the best possible service, George Kent Ltd., Luton, Beds., have announced that a branch office is to be established at Krefeld in the heart of the industrial Ruhr.

The office will have both commercial and technical sales managers, qualified and experienced in all branches of industrial measurement and automatic control. The skilled technical staff will be supported by a comprehensive service and spare-parts department covering the whole of the Kent range of products. The address of the office is George Kent Ltd., Zweigniederlassung für Deutschland, Krefeld — Westparkstrasse, 54. (Telephone: 25692 — Telegr. Kents Krefeld).

Canadian Industrial Fair

Toronto Show to have British Exhibit

IN conjunction with the Board of Trade, the Birmingham Engineering Centre are organising a substantial British engineering exhibit at the National Industrial Production Show of Canada to be held in Toronto from May 4-8 next year. The exhibition, one of the leading specialist industrial shows in Canada, is held every two years and receives widespread support from N. American and European firms. Experience increasingly shows that participation in specialised exhibitions is the most effective method of display on the North American continent.

The show will be held in the Industrial Pavilion at the Exhibition Park in Toronto and although it follows the accepted North American custom of lasting for the comparatively short period of five days, it does provide a genuine sales opportunity for manufacturers of production engineering equipment.

The Engineering Centre will organise the British display on behalf of the Board of Trade, who in addition to the prestige exhibit will also bear the cost of a shell stand scheme for the whole section, adjusted as far as possible to meet the needs of individual exhibitors.

The British section will have the full support of the Board of Trade and the British Trade Commissioner's Offices in Canada, and has the formal sponsorship of the American Society of Mechanical Engineers (Ontario Section), the Canadian Welding Society, and the Canadian Council of Foremen's Clubs.

Firms interested are invited to apply for further details to A. J. Cox, General Manager, Birmingham Engineering Centre, Stephenson Place, Birmingham, 2.

AGENCY CHANGED

AFTER a long association with James Ferguson and Munro Ltd., Evershed and Vignoles Ltd, have decided, as a matter of policy, to terminate the agency and to have direct representation in Scotland.

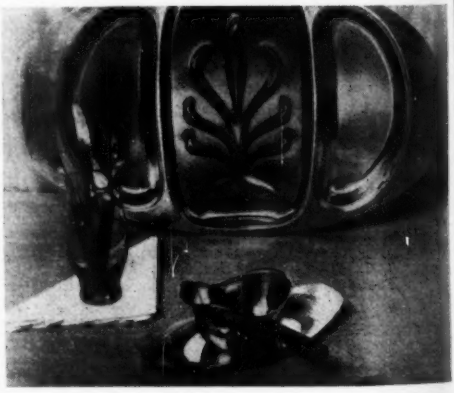
The Scottish area office at 13 Rutland Street, Edinburgh 1 (Telephone: Fountainbridge 3058) is under the management of R. M. Wardrop, Esq., B.Sc. He joined Evershed and Vignoles Ltd., as an instrumentation engineer in 1955.

STAINLESS STEEL FOR U.S. GIFT MARKET

ACCORDING to a market report recently issued by the Republic Steel Corpn., the luxury gift trade, traditionally the domain of silver plate and sterling among the metals, is now a promising new market for domestic stainless steel in the United States.

For the first time U.S. manufacturers of hollowware are turning out trays, platters, serving dishes and accessory pieces of stainless steel for the gift market.

Previously, domestic manufacturers had concentrated on kitchen utensils and kitchen table service, and the market for gift stainless holloware had been left to foreign manufacturers.



Simple lines characterize the stainless steel product

The new stainless steel pieces are designed for formal dining room use, and sold in many of the same department stores, jewellery and gift shops as the traditional table settings. Prices of stainless pieces are competitive with similar pieces made of silver plate.

Kitchen appliances made in stainless steel have earned a reputation for durability with American homemakers, says the report, and modern styling for holloware made of the metal was all that was required to compete with silver plate and sterling silver.

While traditional silver plate and sterling are often ornate and engraved, the chief characteristic of the stainless steel product is simplicity. New designs feature simple lines, smooth surfaces and soft finishes of what U.S. women's magazines call the "modern" look.

The practical appeal of stainless, the steel makers say, carries over from its conventional kitchen use : women like the metal because it does not tarnish and is easy to clean. Using a "butler" finish, the stainless pieces do not generally have the glass-bright appearance of silver, but have a satiny surface that blends with modern table settings.

Standard 18-8 nickel-chromium grades of stainless are used in most cases, for ease of forming and for the easy cleaning characteristic of the material.

Longer Use From Solutions

THE annual report of the British Non-Ferrous Metals Association for 1957 was published recently.

The improvement of the service performance of decorative and protective coatings, particularly the nickel chromium finishes used by the motor industry on steel, brass and zinc-alloy die-castings has been the main work of the Association in this field.

One big step forward says the report is the disproval of the belief, at one time widely held, that nickel plating from baths that had been operated for long periods had inferior corrosion resistance even though it looked satisfactory.

Pilot scale tests lasting many months, on the main industrial processes used, demonstrated that the durability of the product was unaffected.

Incidental to this work, the Association has put into the hands of the plater and his customer new tools for assessing the quality of the deposits. A new thickness meter is being marketed to provide a simple non-destructive test that can be used in the routine examination of most plated components. Along with this, a new test of the durability of a deposit of known thickness which simulates in a short time the effects of atmospheric exposure has also been developed.

TIME AND MOTION STUDY COURSES

TWO full-time 6 week courses, commencing June 23 and August 11 have been organized by the School of Time and Motion Study Ltd., 29, Cork Street, London, W.1.

The school is under the direction of Mr. John W. Hendry, author of "A Manual of Time and Motion Study," published by Pitman.

NEW CHAIRMAN FOR B.I.M.

AT its quarterly meeting in London recently the council of the British Institute of Management elected the Rt. Hon. the Earl of Verulam, J.P., as chairman designate. Lord Verulam is chairman of Enfield Rolling Mills Ltd., Engineering and Lighting Equipment Co. Ltd. and Sternol Ltd. He is also a director of District Bank Ltd. and of Ryder's Seeds (1920) Ltd., a part-time member of the North Thames Gas Board, president of St. Mary's Hospital Medical School and a governor of Bryanston School. At the annual general meeting of the Institute on July 23 Lord Verulam will succeed Mr. Harold Wilmot, C.B.E., chairman and managing director of Beyer, Peacock and Co. Ltd. who retires as chairman of the Institute at the end of his two years of office.

Lord Verulam was educated at Eton and Christ Church, and from 1932 to 1936 worked in the zinc rolling mill of Firma Friedrich von Neumann, Austria, and in the workshops of Vereinigte Deutsche Metallwerke A.-G., Nurnberg, Germany. He founded Enfield Zinc Products Ltd., Tottenham, N.17.

CHANGE OF ADDRESS

THE Birmingham area sales office of Northern Aluminium Co. Ltd., has moved to new premises at Devonshire House, Great Charles Street, Birmingham 3. The office will continue under the management of Mr. D. W. Taylor. Telephone number has been changed to Central 7393, telegraphs: Noralumin Birmingham.

SUCCESS STORY FOR BRUSHMAKERS

THE success story of J. Evans and Son (Portsmouth) Ltd. a British company of precision and special purpose engineers who have been exhibiting new brush-making machinery at the Hanover Fair, held from April 27 to May 6, should do much to encourage other U.K. firms to compete with their overseas rivals, even when these seem impregnably entrenched in their own home markets.

Before the war, brushmaking machinery was virtually a monopoly of German manufacturers. J. Evans and Son successfully entered the field towards the end of the war and for ten years has been exhibiting at overseas exhibitions and selling large numbers of machines all over the world. Today, they are one of the three largest manufacturers in the world, and were the first British manufacturers of brush-making machinery ever to have exhibited in Germany. At the fair, orders for £6,000 worth of goods were received, and the company believes that firm enquiries should bring in an extra £30,000 or so.

New I.C.I. Paint Laboratory

(*Continued from page 285*)

along rails directly into the oven in which the finish is baked hard.

A second booth permits the refinishing of cars in either cellulose or synthetic finishes. Wet-rubbing operations can be carried out on a "rubbing-deck" surrounded by a rectangular drain to permit rapid swilling-down of the area.

The other transport room is intended for the trial of air-drying synthetic paints used on buses and coaches.

The section makes use of electrostatic equipment for experimental painting of motor-car parts and investigates all new types of equipment.

A decorative and marine section provides for paints used in the protection and decoration of every kind of building or structure, as well as for ships and boats.

Colour Advisory Department

The colour advisory department has a largely independent function in the encouragement of good painting by choice of colour.

In addition to a studio there is a display room for the demonstration of various colour effects. Divided into two parts, one has a series of exhibits and models relating colour-theory to practice, and the other has a display of colours arranged in families. There is also a projector and screen.

LEAD, ZINC OUTPUT

TOTAL pig lead (minimum content 99.95 per cent) production in O.E.E.C. producer countries, i.e., Austria, Belgium, Denmark, France, Germany, Greece, Italy, the Netherlands, the United Kingdom and Sweden, as well as in Morocco and Tunisia, amounted to 51,400 metric tons in March 1958 as compared with 48,447 metric tons in February, 1958.

This is an increase of about 3 per cent compared to March of last year.

Zinc production for March was 71,979 metric tons, a decrease over the same month last year of 3 per cent.

CHANGE OF ADDRESS

DESIGNERS and manufacturers of a closed-circuit system of shot blasting, Vacu-Blast Ltd. have now moved into larger premises at Bath Road, Slough, Bucks. Office and works have been combined in larger accommodation, and the new factory retains all the advantages of the previous location, being only twenty-three miles from London within ten miles of London Airport, adjacent to the Great West Road, and with good road and rail services.

During the comparatively short time in which the Vacu-Blast system has been in production, its applications have increased to a wide range of constructional and process industries for an increasing number of applications. The extra accommodation with improved facilities will ensure further development of the equipment. The company has branches in the U.S.A., France, and Australia.

DISTRIBUTION CHANGE

THE arrangements by which R. Cruickshank Ltd. distributed and serviced Efco-Udylite processes non-exclusively have been discontinued from July 1. After this, supplies and technical service will be available to users of the processes in England, Wales and Northern Ireland from Electro-Chemical Engineering Co. Ltd., Sheerwater, Woking, Surrey. Telephone: Woking 5222. The company has depots at Booth Street, Handsworth, Birmingham, 21 (Telephone Birmingham Northern 5466), and at Chaddock Industrial Estate, Astley, near Manchester (Telephone: Atherton 1364).

The Hockley Chemical Co. Ltd., Hockley Hill, Birmingham 18 (Telephone: Northern 6201) will act as selling agents in England and Wales and will provide full technical service to users. They will hold stocks, and have regular delivery services throughout the country.

In Scotland, H. A. Dawson-Bowman, Brisbane House, Rowan Road, Glasgow, S.1, will distribute Efco-Udylite products and provide a technical service in Scotland.

TECHNICAL *and* INDUSTRIAL APPOINTMENTS

Mr. R. H. Cooke has been appointed a director and general manager of **Research and Control Instruments Ltd.** Well known in the instrument industry, Mr. Cooke played a prominent part in organising the British exhibit at the first "Atoms for Peace" Conference in Geneva and serves on the committee of the nucleonics section of the Scientific Instrument Manufacturers' Association (S.I.M.A.). Having been associated for many years with non-destructive testing in industry, he is also a founder member of the Society of Non-Destructive Testing (S.O.N.D.E.).

* * *

Mr. Thomas Johnston, C.H., LL.D., J.P., F.E.I.S., chairman of the North of Scotland Hydro-Electric Board has been appointed president of the **British Electrical Development Association** in succession to Viscount Chandos.

Lt.-Col. E. H. E. Woodward, C.B.E., M.C., T.D., B.Sc. (Eng.), M.I.E.E., has been appointed a vice-president of the Association. Col. Woodward was a member of the British Electricity Authority and the Central Electricity Authority until last December.

Mr. W. N. C. Clinch, M.I.E.E., controller, eastern division, Central Electricity Generating Board, has been elected chairman of the E.D.A. Council, for the year 1958-59, and Mr. T. E. Daniel, M.Eng., M.I.E.E., A.M.I.Mech.E., chairman, North-Western Electricity Board, has been elected vice-chairman.

* * *

Charles M. Hammer has joined the headquarters staff of the **F. J. Stokes Corpn.**, U.S.A., as product specialist on vacuum processing equipment.

From college, Mr. Hammer went to Bethlehem Steel Co., working in the mechanical department at its Johnstown plant. In 1951 he joined A. P. De Sanno and Son, Inc., Phoenixville, Pa., manufacturers of grinding wheels and abrasive cut-off machinery, as assistant manager of its machinery division. He left to join Stokes, one of the U.S.A.'s largest producers of high vacuum processing equipment.

* * *

At the 30th annual meeting of the **American Lead Industries Association** held at the Chase-Park Plaza Hotels, St. Louis, Mo., Mr. John D. Bradley was elected president and chairman of the board of directors of the Association. Mr. F. S. Mulock, Mr. Felix Edgar Wormser and Mr. Kenneth W. Green were elected vice-presidents. Mr. Robert L. Ziegfield continues as secretary-treasurer. One new director, Mr. R. D. Bradford was elected to fill a vacancy on the board.

NEW COMPANIES . . .

"Ltd" is understood, also "Private Co." Figures = Capital, Names = Directors, all unless otherwise indicated.

Consultant Anodisers (Worcester), 346, Wylds Lane, Worcester. April 11. £100. Norris R. Watkins, Laura M. Watkins, Gloria Jackson.

Cottam Stainless, 83 & 85, Princess Street, Sheffield. April 14. £3,000. To carry on bus. of suppliers, designers, manufacturers of and dealers in stainless steel and other steels. G. Baigent.

Dennison Gold Plate, 5, St. Philips Place, Birmingham, 3. April 21. £250. Arthur G. Dennison and Gwendolyne Dennison.

Universal Productions (Enamellers), 22, Aston Road, Norton, Birmingham. April 22. £100. Stanley L. Stubbs, Donald Wheeler.

Surplus Metal Polishing & Plating, 84, Forest Road, London, N.9. April 25. £1,000. Cecil A. Ramsden and Gladys L. Ramsden.

Judd Brothers, 43, Upper Berkeley Street, London, W.1. April 28. £100. To carry on bus. of manufacturers of and dealers in paints, varnish, enamel, etc. Harry Judd.

Jaytee Productions (Stove Enamelling), 55a, Broadway, London, S.W.19. May 2. £100. Geoffrey N. Tipping.

Clarence Products (P.B.T.), 120, Roding Lane North, Woodford Green, Essex. May 6, £100. To carry on bus. of electro, nickel, chromium and cadmium platers, bronzers, etc. Sidney Baynes, Sydney G. Parker, Lewis M. Thomas.

From the Register compiled by Jordan & Sons Ltd. 16, Chancery Lane, London, W.C.2

Latest Developments in PLANT, PROCESSES AND EQUIPMENT

Metal Coating For High Temperature Work.

A NEW high-temperature coating specially designed for the protection from rust of steel chimney stacks, furnace doors and other steelwork subjected to high operational temperatures called "Glostack", was announced recently by Corrosion Ltd., Southampton.

Glostack is a metal coating supplied in liquid form, and is applied by normal paint techniques. It does not need the addition of any hardener, accelerator or curing agent. The surface to be protected is suitably prepared, and the coating is brushed on to the cool surface. The coating becomes touch dry in about 2 hours.

The firm states that experience during development has shown that the coating will stand up to temperatures well over 800°F, for long periods. In addition, it has the important property of being stable and unharmed by a wide range of temperatures from normal atmospheric to the upper limit quoted, and protection is given throughout the temperature range. It will also successfully withstand attack by chemical fumes of the kinds normally found in the vicinity of gas works, electricity power stations, chemical works, etc.

Machine for Sack Emptying

THE specially designed and patented "Dustmaster" sack tipping unit illustrated in Fig. 1 and the first of its kind on the market has been introduced recently by Dallow Lambert & Co. Ltd., Thurmaston, Leicester. External ducting, special hoods, secondary dust problems, etc., have been eliminated, and replaced by a neat and efficient unit.

The unit is designed for easy positioning over hoppers, conveyors, and storage silos, etc. The Dustmaster fabric filter with its unique compactness of design provides 100 sq. ft. of filtration area although it occupies only a small space. Various filter fabrics can be supplied for dusts having peculiar characteristics. The fan, directly driven by a 2-h.p. motor, induces a steady flow of air through the counter-balanced door as the operator tips his sack into the hopper below. Collective efficiency is almost a 100 per cent, the makers claim, and the hinged door automatically closes as the operator withdraws his sack.

No wastage ensues as the periodic shaking of the filter to dislodge accumulated dust results in it being returned to the system. The filter itself is shaken by a simple but effective mechanism supplied as standard equipment with every unit. Its operation may be either manual by an external lever or actuated by a fractional-h.p. motor, controlled by an electronic timer set to work at pre-determined intervals.

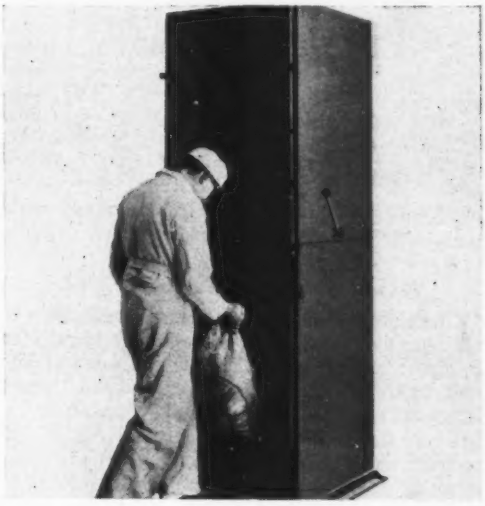


Fig. 1.—Dust-free sack emptying

Filler in Paste Form

A FILLER which can be sanded, ground, sawn, tapped, drilled and feather-edged ten minutes after application, "Isopon" was introduced recently by W. David and Son Ltd., 47/49, Caledonian Road, London, N.1.

It can be used among other things for caulking tanks, as an alternative for lead or solder, for chemically resistant jointings and for filling corrosive pittings, etc. Reinforced with glass fibre the filler need not be applied in layers, nor is any heat treatment required to achieve a rock hardness right through. Unaffected by salt, petrol, water and most acids and alkalines, it adheres to all metals, and many other materials.

Isopon is applied with a putty knife to the prepared surface after mixing the paste with a few drops of hardener and "booster" fluid. A piece of metal or even cardboard used as a "pallette" is all that is necessary in addition.

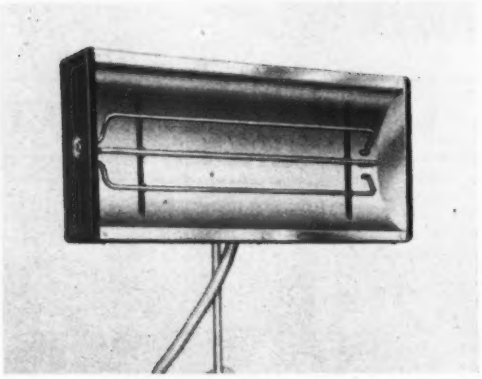


Fig. 2.—Mobile infra-red projector unit is especially useful where the workpiece cannot be moved.

Mobile Infra-Red Projector Unit

There are numerous applications, particularly in paint stoving work, where it is preferable to bring the heating unit to the work and a new mobile unit recently introduced by Metropolitan-Vickers Electrical Co. Ltd., Trafford Park, Manchester 17, has been designed with this in mind. (*Fig.* 2). It is particularly suitable for garage repair work, touching up on production lines, and for stoving or accelerating air-drying paints on large, heavy objects such as castings.

The unit should not be used for drying low flash point finishes without taking suitable precautions, and all such applications should be discussed with the manufacturers.

The unit consisting of a standard Metrovick projector with tubular sheathed elements is mounted on a tripod fitted with rubber-tyred swivelling castors.

While other sizes of projector are available, the equipment has been designed for the 24-in. unit rated 2 to 2.7 kW at standard single phase voltages.

Local switching is provided by a 3-heat switch giving control over 1, 2 or 3 elements. The telescopic tube allows height adjustment from 36 in. above ground to a maximum of 60 in. with the projector in the position shown, while, at the same time, the projector can be swivelled through both horizontal and vertical planes to direct the heat to the desired area.

Metal Spraying Gun

A NEW metal spraying gun, equally suited for use as an individual unit, or as an integral part of a large production set-up, has been introduced by Metallizing Equipment Co. Ltd., Chobham, Woking.

The new unit, known as the " Metco " type K metallizing machine, meets the current trend toward high-speed, semi-automatic, production metal spraying. The many uses for this type of equipment include: hard-facing the friction surface of heavy-duty clutch pressure plates, spraying wear-resistant liners into aluminium cylinder blocks, building-up large hydraulic rams, rolls, shafts, etc., with stainless steel, production salvage of mis-machined parts, and for high-speed deposition of zinc and aluminium for corrosion prevention.

In operation, the gas-head employs the same basic principles as existing Metco metallizing equipment. The metal to be sprayed is in wire form, and is passed through a nozzle where it is heated by an oxygen-gas flame. A blast of compressed air surrounding the wire nozzle, atomises and deposits the metal onto a prepared surface. The resultant deposit ranges from 0.001 in. to $\frac{1}{8}$ in. or more, has the corrosion qualities of the metal sprayed, and extreme wear resistance. The compressed air also keeps the sprayed surface cool.

The wire feed of the type K metallizing machine is driven by a high capacity electric motor, monitored by an electronic speed control system permitting adjustment of wire speed through the entire usable range. The power supply unit maintains constant wire speed, and automatically compensates for all the usual variations in line voltage. It operates from a single phase supply of 110 V.—250 V. A.C. The controls provide high-speed acceleration and dynamic breaking for instantly starting or stopping the wire feed during use, which, together with the speed control can be operated by a remote unit. The motor, gear box and control unit are totally enclosed and sealed to prevent ingress of metallic dust. All rotating parts run on ball bearings and the gears are sealed in gear oil pumped to provide positive lubrication in all operating positions. Heavy-duty components have been used throughout in the construction of the gun and the unit should not need to be taken out of service for overhaul more frequently than once a year or at 2,000 hr. intervals.

A Wash Primer for Metals

A NEW type of wash primer, suitable for all types of metal, has been developed recently by Supra Chemicals and Paints Ltd., Hainge Road, Tividale, Tipton, Staffs.

Called " reactive metal coating ", it has a threefold purpose, i.e., it is a metal pretreatment, an anti-corrosive primer, and an adhesive bond for subsequent paint films.

The valuable properties and uses of etch primers have been known for a considerable time, but certain disadvantages have prevailed which have precluded their use for medium or large scale

production. Main disadvantages have been a pot life of approximately 8 hours and the need for applying the next coating as soon as possible after the primer coat has dried. This necessitated strict control over the quantities mixed to avoid wastage, and the cessation of production of primed parts sufficiently early to allow time for the application of the next coat of paint before finishing work for the day.

The company claim many advantages for the new primer, For example, the pot life of the product is 8 days, and the coating can act as an anti-corrosive primer by itself. Production methods are speeded up because the primer can be applied by flow-coat methods.

The application of the primer is simple as the two ingredients are thoroughly mixed in the proportion of 1 : 1 by volume. Conventional primers for subsequent paint films are not required, and it can be safely applied to all metal surfaces, including steel, copper, aluminium, etc.

Because of the thin film necessary to produce a good anti-corrosive bond, rubbing down before the application of subsequent paint films is not necessary. The material in non-explosive, and the dried film is non-inflammable. Although the flash point is below 73°F, the use of the material is not controlled by the Petroleum Regulations. It will withstand immersion in hot or cold water, or in hot lubricating and cutting oils, and will withstand applied heat. Its electrical insulation properties are good and, as a metal conditioner, the makers say it is easier and cheaper to use than galvanizing and is more efficient than any phosphate deposition method.

A booklet describing the tests carried out on the process can be obtained on application to the manufacturers.

Automatic Grinding and Polishing

THE "Bandomatic" machines made by The Globe Metallic Packing Co. Ltd., Victory Works, Queensbury, Bradford, Yorks., are designed to obviate hand-operated abrasive machines on a wide variety of components by grinding and polishing automatically such items as pressings, castings, strip materials, bars, etc., in flat form. In some instances, where the shape of the component lends itself, fixtures can be provided to hold parts whose form is other than flat. The process is fast and economical, and where both sides of a component have to be finished this also can be arranged automatically.

The machines can be made with one of a number of workheads, as the component or degree of finish requires, and with varying forms of work holders according to need ranging from variable speed conveyor belts to conveyor belts upon which are mounted special fixtures for holding a particular component, and feed roll arrangements in which the material to be processed is fed through power-driven rollers that fully control the material being ground or polished. Special attachments, such as a fine polishing head, can be provided, where required, to meet individual specifications.

The machines can be provided in a wide range of sizes and forms ranging from models having abrasive bands 2-in. wide up to those taking 12-in. wide belts, and can be provided with coolant equipment or for dry operation. All controls are readily accessible and abrasive band changing is quickly carried out without any need for partial dismantling of the equipment. The driving motors are : band 8 h.p., conveyor 1 h.p., with a band speed of 5,000 s.ft. per. min.

American Ultrasonic Cleaning Unit

A NEW self-contained ultrasonic installation for cleaning, immersion or spray rinsing of hospital or industrial equipment is now available from the Branson Ultrasonic Corporation, 40, Brown House Road, Stamford Conn., U.S.A. The Model H-50 "Sonogen" cleaner will process several sets of surgical instruments at the same time, or handle the equivalent in badly-soiled industrial parts. Cleaning takes only a few minutes, with minimum operator attention.

The stainless steel unit measures 27 in. x 36 in. x 42 in. high, with a counter top area of 21 in. x 36 in. Wash and rinse tanks (9 in. x 14 in. x 13 in. deep) are usually arranged for left to right work flow, although model H-50-R for reverse work flow is also available. Installation requires only connections to hot and cold water, to drains, and to a 110-volt, 60-cycle current source.

The Sonogen can be used industrially for removing carbon, grease, small chips and many insoluble soils from intricate parts in minutes. Oil, lapping compound, rouge and cutting fluids have been removed even from sintered metal. Often, assembled units such as servos, anti-friction bearings and electronic sub-assemblies can be cleaned without dismantling, simply by dipping the entire unit in the ultrasonic bath.

The Model H-50 generates pulses of electrical energy at 40,000 c.p.s., which are converted by a transducer into mechanical vibrations of the same ultrasonic frequency. Attached to the bottom of the cleaning tank, the transducer sends its energy uniformly through the detergent or other cleaner. The ultrasonically-agitated liquid quickly loosens and removes contaminants from all work surfaces throughout the tank.

Institute of Vitreous Enamellers

(*Continued from page* 251)

with their principal guests to their places at the top table. Following the dinner the toast of the Institute of Vitreous Enamellers and the Vitreous Enamelling Industry was proposed by Mr. H. V. Shelton, chairman British Bath Manufacturers Association and British Ironfounders Association. Mr. W. T. Wren, president, responded on behalf of the Institute. The toast of the Guests was proposed by Mr. J. H. Gray, Chairman of Council and replied to by Mr. A. E. Peace, president, Institute of British Foundrymen. The evening concluded with dancing to a late hour.

On the following day members and their ladies were provided with the opportunity of paying a whole day visit to the hydro-electric plant at Pitlochry, which constitutes part of the Tummel Valley scheme. The opportunity was taken during the course of the Conference to stage a golf competition, which it is hoped will become an annual event in the Institute's calendar. This year's competition was won by Mr. C. J. Baines, with Mr. S. W. Barkhouse as runner-up.

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to consist basically of applying a pigment in a suitable vehicle to prepared surfaces by spraying or roller coating and processing under controlled temperature and atmospheric conditions.

Magnetic jigs are, of course, fairly well known in plating circles, but the use of magnets to hold components during conveyorized dip painting is new to me.[8] Due to the different sizes and shapes of mining tools being manufactured at an American Company, it was difficult to find a fixture to hold them all during painting. A satisfactory solution was found by suspending more than 400 horseshoe magnets from the conveyor chain with wire loops.

References

(1) *Light Metal Age*, 1958, Feb., pp. 12-13.
(2) *Products Finishing*, 1958, Apr., pp. 26-33
(3) *Plating*, 1958, Feb., pp. 144-150.
(4) *Metal Progress*, 1958, Apr., pp. 90-92.
(5) *Metal Finishing*, 1958, Apr., pp. 56-57.
(6) *Iron Age*, 1958, June 5, p. 87.
(7) *Steel*, 1958, May 12, pp. 88-89.
(8) *Products Finishing*, 1958, Apr., pp. 46-47.